The STRUGGLE *for* HEALTH

By DR. RICHARD H. HOFFMANN

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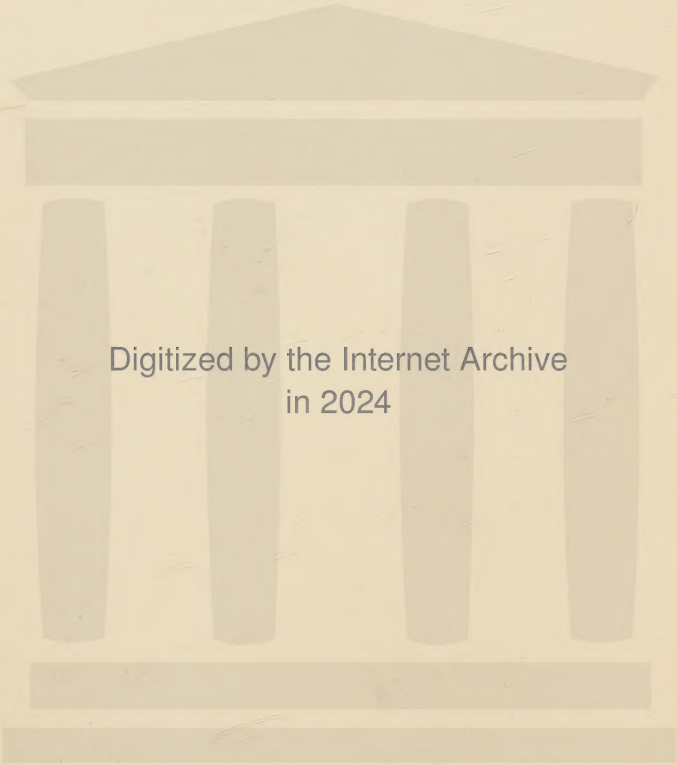
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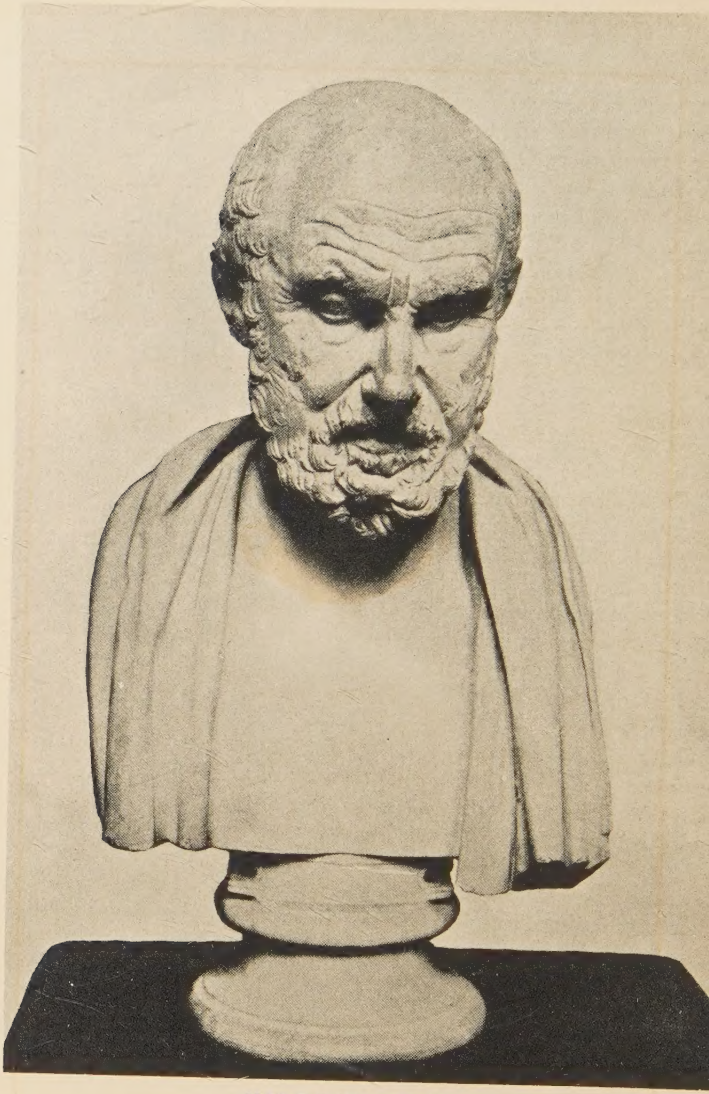

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The STRUGGLE *for* HEALTH

By DR. RICHARD H. HOFFMANN

Illustrated

NEW YORK
HORACE LIVERIGHT
1929

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To

MY MOTHER

WHO IS ONE OF THE
BEST DOCTORS I KNOW

I WANT to thank my very dear friend, Gilbert Swan, to whom I owe an especial debt of gratitude for his most valuable assistance and collaboration.

PREFACE

I WAS largely prompted to write "The Struggle for Health" by the fact that in my contact with patients over a period of twenty years, I found them woefully lacking in understanding the nature of "the ills that flesh is heir to," and that the average patient presented two problems: first there was the malady with which the patient was afflicted; second, and just as important, was his mental reaction to that malady usually inspiring apprehension and fear.

In many instances, disease is a benign manifestation. It is the knock in the motor that calls attention to a minor defect, the correction of which once more insures a smoothly running machine. It is frequently nature's way of dictating a rest from daily toil and the stress and strain of living that permits a return to health and comfort.

One thing is true. We are born to die. Sometimes death creeps upon us insidiously and sometimes it comes with swift and sudden stroke. That period between birth and death which is called life, is frequently punctuated by deviations from normal health and point of view, and these intervals of distortion we call disease. I have tried to show in these pages how, since the beginning of time, man has recognized and fought against those diseases that contribute to his suffering and shorten his days.

I have tried to show the romantic side of the pilgrimage for health and to tell my readers of the fantastically heroic crusades that were undertaken in its pursuit.

Here and there I have singled out one of the great pioneers who have planted their milestones of discovery upon this endless march toward the enlightening and cheering of mankind.

The struggle for health must be the oldest epic in the history of man. We cannot conceive that man ever lived without desiring life, and that he must have used every form of faith and fact to forestall the grim reaper. At present man is in the very thick of the struggle and day by day he is actually adding to his life span.

The plagues and pestilence known to our forefathers are happily banished from civilized countries. Yet only ten years ago in 1918, an epidemic of influenza took a greater toll of human life in America than the great war.

I have further tried in these pages to elucidate the mysterious influences that cause diseases, to show how they were discovered, and to describe the means that are being used to combat them.

In the compilation of the material for this story of "The Struggle for Health" I am indebted to many published sources of information. An active practice of medicine gives a physician little leisure for recreation, so that it has taken me about three years to collect my data. During this time I consulted many histories and many biographical records of the great men who won their spurs in the struggle. It is impossible to name all the references, particularly the special articles appearing in the medical magazines and transcripts of ancient documents. The books most freely consulted were:

Garrison, *An Introduction to the History of Medicine*
Osler, *Evolution of Modern Medicine*
Hartzog, *Trails of Medicine*
Moodie, *Diseases Among Fossil Man*
Braddeley, *Æsculapius and His Heirs*
Buck, *Dawn of Modern Medicine*
Ferguson, *Priests of Æsculapius*
Caton, *Temples and Rituals of Æsculapius*
Ayer, *Healing Gods of Ancient Times*
Dacier, *Pythagoras*
Pomeranz, *Infancy of Surgery and Medicine*
Comston, *Introduction to Medical History*
Billings, *Progress of Medicine*
Luciani, *Physiology*
Longcope, *Milestones in Medicine*
Selzman, *Medieval Medicine*
Ostwald, *Historic Dawn of Chemistry*
Armitage, *History of Chemistry*
Waite, *Secret Traditions in Alchemy*
Dalton, *Galen and Paracelsus*

HENDE, *The School of Salarnum*
FOOTE, *Arabian and Medieval Surgery*
PAGET, *Ambrose Paré and His Times*
SENN, *Pompeian Surgery*
LEE, *Scientific Feature of Medicine*
WATSON, *Practice of Physic*
MONPHER, *Surgical Memories*
BURROUGHS WELLCOME, *Historical Pamphlets*
DUCK, *Lord Lister*
WELCH, *Progress of Modern Medicine*

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THE STRUGGLE FOR HEALTH

The words of Juvenal, the Roman poet-philosopher, that the "ultimate quest of man is a sound mind in a sound body" are timeless. They echoed out of the primeval forest and they will prevail until the day of judgment.

CHAPTER I

Life Will Find a Way

ONCE upon a time, there came an icy wind. But, unlike other winds that swept the forest, it did not last for a day or two and then succumb to the appearance of a friendly sun. It remained; it persisted; it became more intense. All things animate began to shiver, first from a sensation of cold and then from a feeling of impending danger.

An immeasurable sea of ice had gone adrift, breaking loose from its Arctic moorings, and had begun a journey that threatened to destroy the whole earth. It carved its way through mountains or leveled them. It dug great canyons and modeled valleys. Even as a plow turns the soil, it ripped through the crust of the earth. Slowly, steadily, and with unremitting perseverance, the prodigious mass closed in upon almost all of our primordial ancestors, sending its sinister breath ahead.

Up in the trees, where they carried on their apparently purposeless existences, they paused. For the first time they came face to face with an enemy that did not slay at once, or even wound, yet its menace created a constant distress that demanded decisive action.

This was a new problem, different from all other problems. The forces of Nature had created the most critical situation in all Time, a sort of crossroads between life and death. What should they do?

They waited. After all, had they not for eons enjoyed the bounty of some incomprehensible power that permitted them to live and thrive and multiply?

Meanwhile, it grew colder and colder. . . .

Tom, Dick and Harry "Dawn-Man" stood, no doubt, in a circle, chattering as you have heard birds chatter before they fly South; or as you may have seen groups of monkeys chatter in the face of some anxiety. It was the first survival meeting. What were they to do?

Reason and instinct prompt man in all emergencies. Our own erudite imaginations may only speculate upon the outcome of their powwow.

One of them, let us presume, decided to remain in the trees, skipping along in advance of the avalanche, and paying a blind and brutish allegiance to Chance. And he remained an Ape. The second decided to stay at home. Perhaps he was too old to go on. Perhaps he was held by some attachment to the home of his ancestors, or by a desperate hope that the thing would pass. And he died there—leaving to posterity the enigmatic proof of his existence: a thick, low-browed skull that would perplex some future Darwin who would be born centuries after this sea of ice had melted into poetic lakes and rivers. But the third shook his head. To both of their decisions his answer was a decided "No." Something was stirring within him. Something he could not understand. Some impulse. Some new concept, born of a fear-enkindled light, that swept across his sluggish intelligence. Whatever this thing was that had suddenly transformed him, he did not know. An inner light was glowing. He would leave the trees. He would make his panicky way along the ground. It would be unnatural, clumsy, even painful. He would have to stand erect—upright—walking, instead of climbing as was his habit. There would be new duties for his forelegs. Building shelters. Carrying burdens. Fighting. Protecting himself against the elements and the dangers of the trail.

But it was the only way. The idea had burst upon him and finding expression in gesture and gibberish, he fired the vacillation of his fellows to the point of conviction. Like some inspired Apostle he must have seemed, at times imploring, at times bullying his companions to follow him. Nothing that he had ever conceived before or done since could match the splendid heights of that resolve. Dawn-Man was on his way to abandon the Ape and become Man. In that moment he himself was greater than any god he could conceive.

And so, cheered by their leader, and answering a heroic faith in their destiny, this band of aboriginal pioneers went forth to penetrate the mysterious reaches of an unknown world, leaving behind them millions of years of habit. The most magnificent adventure in all time was about to begin. This was not merely a migration

PITHECANTHROPUS ERECTUS

from one land into another of greater promise. It was a trek into the transformation of the very nature of Dawn-Man's being. Companioned by uncertainty, and shadowed by fear, facing dangers far greater than any they had left behind, they rose upon their hind-legs, and beating their shaggy chests with hairy arms, bellowed a mournful farewell to their tree-top cradles. No rock will ever be found on which appears the name of Mr. Dawn-Man, no banner under which he went forth, and yet your existence and mine depend directly upon this divine inspiration.

To us to-day, the idea of walking or running is too simple, too mechanical to require even passing attention. Yet, it is interesting to note that our children must be taught to walk and that it takes them a year to coördinate their movements and acquire the proper sense of balance. Man has paid for this privilege of walking instead of creeping and crawling—and has paid dearly. He has paid with one-third of his conscious life. He has paid with fatigue and with disturbances of function and with disease. Nature had ordained that human organs hang from a horizontal rather than from a vertical carriage of the spine. When man stood erect, not only was a strain placed upon the ligaments that suspended his organs, but his entire circulation was embarrassed. This produced fatigue, and in order to compensate for his weariness, man requires at least eight hours of sleep. No animal needs as much.

Let us follow these near-men for a while upon their march. Instinct, that blind gift from an all-seeing Power, had taught them many things. They learned, first of all, that life was the important thing and that death meant its end. They learned that between life and death there were intervals:—Intervals of pain and pang, intervals of change in form and in disposition. Intervals that approached the end of all things, and others that evaded its mysterious climax. In other words, they learned the difference between capacity and incapacity, power and weakness, health and disease.

The first and foremost problem encountered by them was the change in food. From their old vegetarian diet of nuts and fruit, it now became necessary to eat meat, and killing game involved the invention of weapons. It is not unlikely that meat was at first distasteful to them, that some actually became ill from it and had to fall behind.

Then followed the discovery of fire and the creation of the tribal camp about it. Only a poet can portray the sense of joy and exultation that must have been theirs when these first flames brought relief from the intolerable chill of night and comfort came to their sleeping hours. Again, there were those unfitted for the rigors of the trek, and those who could not manipulate in this new erect posture and fell back upon their haunches or returned to the trees. There were the readjustments of tribal life, the losses of leaders who had to be supplanted by the oldest and the wisest or the strongest and the bravest. Here, only health and brawn, sharp instinct and quick decision availed.

It was inevitable that a thousand new situations would be encountered and overcome. There were changes in climate. There were the ever-varying changes in environment. The instinct of self-preservation prodded their brute brains and compelled them to think. In order to live, they had to contrive many new devices for their survival.

Security is a prime factor in the instinct of self-preservation and comfort is its favorite hand-maiden. In the struggle for security and the acquisition of comfort lies the beginning of the struggle for health.

Sensation was their first guide. They were either comfortable or uncomfortable. They were too warm or too cold. They were agile or tired. They were distressed or had a sense of well-being. Again —they felt secure or insecure, safe or in peril, and, running through the cycle of the ages, it has ever been the same.

Plodding down through time, man has learned the meanings of many things and the reasons for them, and his life span in the pursuit of peace and happiness has accordingly been lengthened. But in these early days all things were new to him. He had not reasoned about them. He was just beginning to think. He remembered seeing a monkey pull a thorn from its flesh and cover the bleeding spot with a leaf, pressing upon it till the bleeding stopped, and thus performed the first surgical operation. Was not this the forerunner of the compression bandage we use to-day when we want to control bleeding from an incised wound? He learned that some leaves irritated and others soothed. He, therefore, probably avoided the poison ivy and used a plant with gentler attributes. He had

seen the effects of the sting of an insect, with its burning pain and swelling, and recalled that his ancestors sucked and licked the poison from the wound; and he applied the same method to himself.

He watched his child, bitten by an asp, die in convulsions and he soon learned how rapidly the poison of the viper courses through the body of its victim.

He came upon an animal nibbling upon certain grasses and roots, and making imitative investigations, stumbled upon a cathartic or opiate or one of the many drugs that are used to-day for the assuagement of our illnesses and the cure of our indiscretions.

He had watched a dog partake unwisely and too well of a meat that had lain too long in the sun, and he had seen the animal become limp and lethargic where it had been prancing and gay. He had seen that dog eat grass, and seen this grass emitted, and with it the partially digested food. He had learned that certain grasses were good for gluttony, in that they removed poisonous substances which we know to-day as ptomaines. He had seen warm animals seek out cooling water and tired animals stretch their legs in the sun to bake out the soreness. He had seen cold and wet animals rub themselves with clay and let the sun bake it on and he got the idea for his first coat.

Hunger and thirst were instincts to be appeased. Men must eat and drink to live. The running rivers were supplying plenty of cool water and the fleeing animals sufficient of game. The trees bore fruit, the fields nourishing vegetables. But game was not easy to get. Some was too swift. Some was more powerful than man and destroyed him. Some was unsavory and unpalatable. All that grew in or from the ground was not hospitable to his existence. Some of the plants made him sick, gave him excruciating pains and produced sinister changes in disposition. Some killed him swiftly. Some left him hungry though he had eaten in abundance. So it took generation after generation to experiment and sift and distinguish and differentiate between what is a man's meat and what is his poison.

Time has proved the value and advantage of mixed diet. On the whole, man had taken his food as he found it and attempted to sustain life with it. Thus, the Eskimo in his Northland igloo found the blubber of whales the most palatable dish and one eminently

fitted for the icy clime. Remove the Eskimo to a country where other foods are served and no blubber is obtainable, and he quickly dies of tuberculosis. The wandering Arab hordes have subsisted on camel's milk and dates, fruits and nuts. Removed from this diet their health is almost immediately menaced. But the white races, those who to-day are accustomed to a varied meal, can be transported into almost any clime and accustom themselves to the rations.

The March of Ascent was dominated by one essential—Health. Health to our remote ancestors was unawareness of disease. It meant a balanced relationship between the desire to do and the capacity for doing. The body must be free from pain and the mind unplagued by persecution.

With the climatic changes, that resulted from the successive meltings and renewed advances of the ice, generation after generation had to adapt itself to new abodes. They saw varying forms of flora and fauna, different plants and different animals; they saw that some of the animals that they had known for generations past were disappearing and that others were compelled to change their habits. They found that those who were fleet of foot and lithe of body and thick of coat and strong of head and hoof, remained, while others perished. They saw that those who nursed their young survived in greater number than those who fed them with spoils of the hunt. Here was an example for man to follow. Animals that were massive and cumbersome got in their own way and were left behind. Monsters that were defiant, relying upon their own strength, perished, powerless before their icy enemy. Size of head prevailed over size of body, and brute force that killed at a single blow availed nothing in the struggle for survival. It began to be more important to think than to beat your way into survival.

Like the animals, the man-to-be turned to the caves for shelter. Here he could be protected from the icy winds, build a fire and cook the food. Here he could also build a defense against ravagers. Many a group, tasting the first home-instinct in these caves, abandoned the march and died here, leaving as relics of its existence the piles of chewed bones and layers of flint and stone that archæologists now come upon.

Let us imagine one group living in a crevasse. Here an animal or an enemy attacked them, and the male, standing at the adit with

his womenfolk and his children behind him, made ready to protect them with his life. As his great hands pawed the neighboring bowlders, a rock came loose and fell snugly into his open hand. With terrific force he hurled it at his enemy. Chance sent the bowlder true to its target. The attacker either collapsed or ran off in pain. On another day, when another enemy approached, he reached again for a rock, and again found it effective. Thereafter, his lesson learned, he moved his dwelling place to some spot where rocks and stones were plentiful and taught his offspring to throw with strength and accuracy.

To-day, the youngsters of this nation play a game in which the object is to throw a ball at a given target. It is, in fact, the national game—"baseball." This talent was handed down through the ages where once it was a means of survival, to become a form of recreation and play. Boys play it almost instinctively, but how many girls are able to throw a ball with speed and accuracy? For hurling stones was man's game. Woman's was to cower in some safe place, nestling her brood against harm.

Then there were times when for no apparent reason men became ill. Why did the old men of the tribe complain of achings in the muscles and strange sorenesses? What were the alternate sensations of cold with creepy flesh, and heat with dry and burning skin, that first incapacitated them and finally left them lifeless? The wanderers looked about them. Fear seized their souls and finally possessed them. Panic caused them to crawl into caves and remain within their shelter. All to no avail. How could they deal with an enemy they could not see? For the victim of the chill and fever had seen no one. He had been attacked with invisible weapons. Who was this secret enemy, and where did he hide? Did he fall from the sky or steal upon them from the recesses of rock? Did he come upon them while they were asleep? The terror of the unknown had overcome man and mystified him as never before. Perhaps it would be well to try to make a friend of this enemy. Perhaps if a fine reindeer skin or an ornament were left outside the cave for him, he would be propitiated and disappear. Of course men tried it, often with failure, but still with persistence, until one day, the season changed. Chill and damp were dispersed. The people of the tribe could come out of their caves and revel in the

sunlight. Their aches and pains left them. Their sacrifice had worked. Wise indeed was the old man who had thought of it. It was in this way, mysterious influences coming upon man from sources just as mysterious, and acting at times to his benefit and at times to his destruction, that the gods and demons found origin in the primitive fantasy of man.

From the very beginning wisdom was attributed to the aged. Those, older in experience and cooler in blood, became the sages and dictated the laws and established the customs that in their sober opinion would tend to make life more secure. How were the young to be taught the meaning of things? How were the perpetual questions of the adolescent to be answered when he came to ask the why and the wherefore of a mystery? How were they to explain those strange visitations at night that came in dreams, and filled the brain with horror, and foreboding, and at times with strange delights? Who was responsible for the extremes of human passion and human woe? Why were the young and strong taken away with swift and sudden stroke and the old and maimed permitted to eke out their long existences? These questions were all answered by the sages and the responsibility placed upon the shoulders of unseen beings.

The scrolls of destiny were written by the powerful hands of gods and demons, and the scepter of fate swayed by them. Gods and demons, spirits of omnipotence, living in the vast infinitudes of space and visiting the earth at will, exercised their power over man. These spirits had to be pleased, patronized and propitiated. They would be bought with gifts and emoluments, or be swayed with baubles and sacrifices, with chants and dances in their honor. They were invisible and yet very awesome and were to be respected and feared. Deities, then, were born out of terror and ignorance, in the toddling steps of time, and have presided over terror and ignorance to the present day.

So when a man was sick or irrational, when he fell a victim to any of the ills that flesh and mind are heir to, he was considered to be possessed by an evil spirit that had entered his head and that had to be removed by incantation and propitiation. At times this was done in a more material way, as primitive skulls, recently unearthed, have taught us.

When a stricken tribesman held his head in persistent pain or

when his animation was suspended for a considerable period of time, they would call upon one of the younger men and bid him prepare a well pointed drill of flint. The usual appeals were made to the tormenting spirits and then gradually, patiently, they would begin to bore a hole through the skull of the afflicted one. According to their belief, this was necessary to let out the evil spirits that possessed him. Generally it required three of their wise men to perform this operation. They held their patient down so that he could not struggle or even move, or else they bound him. Quickly the flint was twirled between the thumbs of one of the sages while its sharp point penetrated the skull. Into the wound, one of the assistants patiently poured drops of a specially prepared potion which had been warmed over the camp fire.

It was a slow process—this earliest of trepannings. Sometimes it required a week or eight days before the skull had been completely bored through. Sometimes the patient lived and the tribesmen rejoiced that the demons had departed from him through the hole in his head. Generally he died and then, of course, the sage could but shake his head and hold that the demons had been too powerful to be banished. Thus, in the earliest dawn of time, was performed an operation which, even in this advanced scientific age, is looked upon as a most serious undertaking. Archæologists who have made a particular study of primitive skulls report that the operation was performed in many lands. Perhaps nomadic tribes carried it from one land to another, for certain it is that tens of thousands of uncovered skulls show the marks of trepanning.

In the eons that passed, while man was "growing up," the gigantic floe of ice had slid like a great frozen knife over Europe, cutting down forests and fields and all growing things and leaving behind it one vast open steppe. When it had passed, there remained for many a season a wind so cold that no vegetation could grow. Long since the reindeer and the musk-ox and other animals of the North had been driven southward with man to new feeding grounds. Some of the tribesfolk stopped in the first lush, warm valley they came upon. Some, not content, pushed on into Eastern Asia. Some made their way to Arabia and India, gradually penetrating most of Africa and slowly evolving the dark races of the world. As the centuries passed, other tribesmen wandered to the Americas, and to

Australia, where their brothers still live in unspoiled savagery. Those who had not wandered so far drifted back into Europe, settling France, England, Germany and other countries. For now, the warm suns had come again and Time had healed the bruised fields and forests. Once more the bushes blossomed and the forests grew and Nature was giving her last children shelter and food.

So it went on: one change and then another; new hardships, new struggles, all in the great eternal effort to live.

Let us attempt a picture of a typical group. For many years, perhaps many generations, wandering tribesfolk had dwelt in a fertile valley where a picturesque river meandered behind adjoining hills. They had selected this as their homeland. Family life had developed. A sense of ownership and property right had been born. The tribe was prospering. There had been no invaders and hence no war. They had learned how to tan the skins of the reindeer and how to make coverings for their bodies to protect them from the inclemencies of the weather. Most interesting of all, the artist was born among them and the primitive caves reveal amazingly correct pictures that they carved upon rock-walls.

The history of the human race cannot date, nor does it attempt to postulate, the method or means by which one of the greatest strides toward civilization was made, and one which contributed a most important factor in man's struggle for health and survival—namely, the domestication of animals. It is logical to suppose that the putrefaction of animals killed in the chase was a very prevalent cause of disease and that in many instances the propitiation of the false gods had failed. Perhaps then men thought these animals should not be killed. Perhaps their friendship should be won. So they naturally took into camp those animals which were least aggressive and most easily captured, and which had supplied them with palatable and nourishing food. The dog, the horse, and the cow were among man's earliest companions. Anthropologists penetrating the past have found the bones of dogs mingled with those of their masters; so it would seem that, even as to-day, the dog accompanied man on the hunt or guarded his hut while he was away. In mythology, it is a dog, Cerberus, that guards the mouth of Hell and is symbolized with three heads so that he can see in all directions. The first wild horse that was tamed was, in all likelihood, the

little five-toed Eohippus, whose flesh was not sufficiently palatable, and he was developed into a beast of burden. The goat and the cow were used for their milk and were responsible for a drastic change in man's diet. Milk, butter and cheese were added. And so little by little through the centuries, their habitations became farmyards of cattle, goats, pigs, horses, dogs and fowl.

It was about at this time that man discovered seeds that burst into grain and began to plant them. By this practice of raising his own food, he built another barrier against necessity and took another step toward civilization. But there are some who have never learned this lesson of husbandry. To this day certain aborigines of Australia plant no crops, and forage for nuts, fruits, greens, and game as did their arboreal brothers.

Naturally, these changes in life were largely responsible for the development of the home impulse in the first wanderers. Their nomadic life came to an end and their war-like tendencies were lessened to a considerable degree. But a day came when this peaceful, rural life was broken by the charging hordes of big men from the North, stern fighters who moved southward on conquest bent, achieving victory over the rural people. But once the newcomers had conquered, they stayed, taking over the lands of the conquered, marrying their women and adopting their ways. Little by little, century by century, man lived and learned and progressed and handed down to his children the knowledge of past experiences to which he added the tithe of his own. The story has been unearthed by the spade, in stones and bones, and its fascinating drama takes us back millions of years. Bit by bit we fashion its mosaic out of relics seen in museums, stepping one rung at a time up the ladder of progress and civilization.

What, you may ask, has all of this to do with "The Struggle for Health"? This: The Bard of Avon called man the paragon of animals, and from a biological standpoint, this paragon was put upon earth for two fundamental reasons. First, to eat and breathe—that he might grow and supply energy to his tissues, and thus establish the survival of his body. Second, to love—that he might beget, and insure the survival of his race. When man has done these two things, he has satisfied all the demands that primal nature has made upon him.

Simply stated, man is to-day the sum total of his ancestry, all that heredity has contributed to his make-up plus the mite that he adds to himself through the influence of his environment and his upbringing. Having safely crossed the bridge of birth, and having been immune to those accidents and diseases that maim and afflict, he has about as much chance of influencing his destiny as has his span of life of influencing Eternity. Man inherits his features, his traits, his tendencies, his character, from his ancestors. Modern psychologists have waged war against these tenets, and have attempted to prove by many isolated cases that environment shapes our careers. It undoubtedly does shape our careers to a certain degree, and influences our social adjustment, but it does not affect how we feel about them. The germ plasm from which we spring is unchanging. Even as a hen's egg will always hatch out a chick bearing characteristics of its progenitor, so will human eggs develop into men and women having the characteristics of their ancestors.

The Bible states that the sins of the parents shall be visited upon their children until several generations. It is not the letter of the law in which we are interested. The fact remains that the great passions of life—love, fear, the pursuit of happiness, the sense of security, the exhibition of tastes, and the assertion of principles, have changed very little to-day from what they were at the dawn of civilization. Our intellectual development, especially in the discovery of natural truth, has happily enabled human reason to quell and check our unrestrained pursuits of emotion.

Changes and variations have undoubtedly taken place throughout the eons of human existence. Modern man does vary from his tree-inhabiting ancestors with whom our story begins. Man has progressed and developed. Darwin's theory of adaptation is the most plausible explanation of man's survival. Human emotions, however, varying only in degree, inspire poet and peasant. In both criminal and saint reside the potentialities for good and evil expression. The important thing is that man had to live and that health was the most important quest of life. Let us see how he has achieved his modern status.

HALL FLETCHER
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CHAPTER II

From Myth and Magic to Moses

DURING the month of May, 1927, there appeared in an Atlanta, Georgia, newspaper an advertisement which read something like this:

I guarantee to heal all kinds of sickness, destroy evil influences, cast off spells, remove your enemies, and change the conditions of your entire life.

All of which would seem to indicate that the voodoo of the jungle is not so far from our own back doors.

Upon a farm in Thebes, there was uncovered, about 1862, a scroll which, when deciphered by Egyptologists, was found to contain recipes for magic, incantations to be recited or chanted on all sorts of occasions, and a great list of remedies for human ills. The third paragraph in the papyrus has peculiar interest since it is an incantation "for the purpose of transforming an old man into a youth of 20." The date of this document is fixed at about 1700 B.C.

. . . . . .

These two paragraphs—one written before our very eyes, the other long hidden in a moldy crypt—prove how timeless are man's most wistful searches: first, for an escape from every sort of pain; second, for a Fountain of Youth. In the hope of obtaining them, he has petulantly pursued the rainbow's end, and made the most futile, fantastic and fervid obeisances to Pagan promises and hoodwinking ritual.

We can only surmise what happened in the blank eons that antedated the first written word or symbol. Here and there, a trail of flint chips; crude drawings left on cave walls; instruments, implements and utensils of undated time tell the same story: health and survival were of first and last moment to our forefathers.

When young, did you by chance happen to live in an old, old house, to which tradition clung like dust-dried cobwebs? Perhaps your family moved away, and when you grew older the old place became as dim to your memory as a ship passing in a fog. Late in life you went back to see the old house again. You could scarcely find it; but somebody showed you the way. It had been remodeled, and completely redecorated. You prowled about, vainly looking for some trace of the past, some association with your youth that lived in memory. Finally, let us assume, you went to the garret. And there was an old trunk, enameled with dust, and fast crumbling apart. Yes, and here you found a yellowed bundle of magazines that recalled long winter days of childhood, and some old clothes and games and books and odd knickknacks that brought sentimental tears to your eyes—all hyphens connecting lost years. You went away, wondering what families had come and gone; what tragedies and comedies had been enacted in the old house in the intervening years. No one had kept records. No one could tell you. You would stand before an almost unsolvable perplexity. Like a detective you would have to consult clew upon clew to reconstruct the past.

And just so the anthropologist and archæologist have gone back to man's first home and have tried to trace the comings and goings of myriads of ages, of peoples, of civilizations—over millions of years.

Out from the trails of flint and stone, weapons and pottery, bones and fossils, comes suddenly the written word of the papyri and the graven stories of the hieroglyphs.

What are these written scrolls?

Incantations to be chanted over the sick, dying and dead. And these incantations were the beginning of music and the beginning of poetry. Out of them grew religious chants and spirituals. Any one who has been sufficiently interested in jazz to trace its sources has been told that it grew up from the jungle, that it echoed the rhythmic beat of the tom-tom. This wild jungle music is merely another form of the earliest application of magic through which, it was assumed, demons could be driven from the bodies of the ailing. All religious hymnals and exorcisings are but variations on this most ancient theme.

What are these records, you ask? The two most ancient are the Ebers and Smith papyrus.

Edwin Smith was an American farmer. He had acquired some land near Luxor, in Thebes, and in addition to agriculture had become interested in Egyptian relics. He became a dealer in all sorts of ancient curios, and developed from farmer into Egyptologist. His home was built on a site identified as the one-time location of a temple of Rameses II. In his excavations, Smith came upon a papyrus that had been placed between the feet of a mummy.

There is a superstition that has driven fear into the hearts of the most rational moderns to the effect that the ancient gods punish those despoilers who ravage the tombs of the venerable dead. Did not Lord Carnarvon die most mysteriously after uncovering the tomb of Tut-Ankh-Amen?

One day Smith returned from a game of "hide and go seek" with mummies to find that his home had been ransacked and fired. The precious papyrus, which he had carefully hidden, was unharmed. A few days later, however, Smith dropped out of sight. No trace of him has been found from that day to this.

Some ten years after the Smith papyrus was unearthed, a German Egyptologist, Georg Ebers, found himself handicapped by the strain of overwork. He decided to travel in Egypt and restore his nervous energy by diverting himself with hieroglyphics. He had heard of a papyrus, more ancient than all others. He examined the Smith scrolls. To his disappointment he found that these were not the object of his search. Somewhere there was another, and it fell into his hands in a most unexpected manner. An Arab, who had been acting as a guide, appeared one day with a scroll which, he explained, had been found in an ancient jar. Ebers glanced at it and turning it over, found some crude zodiacal figures which marked it as the very papyrus for which he had been searching—perhaps the oldest bit of writing in existence. He bargained with the Arab, who held out for what he considered the exorbitant price of $8,000. The money was raised immediately by the German government and the papyrus is to-day in its possession.

The Ebers papyrus is 65 feet long by 14 inches in width. It was written before the pyramids were completed. It proved to contain a series of highly emotional pleas for deliverance from

every conceivable ill, and suggestions on how to relieve human distress.

Typical of the content is this bit from the preface of the Ebers document: "O Isis, great goddess of incantations, deliver me, free me from all bad, evil and cruel things; deliver me from the god of pain, from the goddess of pain and death . . . for I have entered into fire, I have come out of water, I have not fallen into the snare of 'Today.'"

And this—to be incanted when remedies were applied: "Come, remedies, come and expel the woes of my heart and of my limbs."

Or this—to be used when an emetic is taken: "O demon who art within the abdomen, whose name is death and whose name is the male of death, whose name is accursed to the end, leave me!"

To drive away the "disease of fat," as tumors were called, the following "suggestion" was made: "If thou findest fat in any part of the body and it goeth hither and thither with the fingers, and trembles, say of it, 'It is the fatty tumors,' and treat it with a knife as one treateth an open wound."

Or again: "If the limbs are heavy, as with palsy, lay your hands upon the stomach and find if it is swollen. If so, say of it, 'There is a defect of digestion of food. Let him have no more food and prepare for him a purgative.'"

In one papyrus castor oil is mentioned fifteen times, which reassures one that little Johnny's aversion to this particular remedy was shared by little Rameses.

Such a remedy was taken after uttering some such words as these and repeating them over and over again: "May these words expel the painful creeping within my belly. It is a god that has created this enemy! May he charm it and expel it."

This form of treatment, by the way, has never completely gone out of style. Have you already forgotten one M. Coué, who came out of Nancy, in France, and caused a considerable number of our people to pass a string through their fingers and repeat over and over, "Every day in every way I am getting better and better"?

There is, indeed, slight difference between the formula of the ancient Egyptians and that with which M. Coué created his vogue. The idea of the knotted string being passed through the fingers is to be found in Chinese writings that tell of customs as far back

as 3000 B.C., when divination and magic were associated with knotted strings.

Magic, then, was the curative measure of all early peoples. The records of Persia, Babylon, Assyria, China, as well as Egypt, tell similar stories. The methods change triflingly and the gods bear different names, but the chants carry the same burden. For instance, the Assyrian:

"Arise, ye great gods, and hear my complaint. May the sorceress die! Let me live! May her charm, her witchcraft, her sorcery be broken. May the plucked sprig of the binu tree purify me; may it release me. May the evil odor of my mouth be scattered to the winds. [Halitosis again!] May the mastakal herb which fills the earth cleanse me. . . ."

And so it goes! Perhaps, however, the best way to comprehend the mutual trend of the ancients is to glance for a moment at the practices of the aboriginal peoples of our own day. The ancients, to be sure, had achieved a far higher state of civilization and had a far greater development of intellect, but their superstitions and magical rites were about the same.

Take, for instance, the head-hunters of Borneo; their practice of bringing home heads is more than a barbaric gesture. It is grounded in the idea, explorers tell us, that the virtues and the strength of the man who once possessed the head will enter the body of him who cut it off. It is the thing one must do to achieve maturity. One cannot go courting unless manhood has been achieved and proven by displaying an enemy head. Virility and strength are presumed to be gained by the fetish.

Among many of the ancients, the passing of puberty was signalized by the operation of circumcision. The very earliest carvings depict the performance. No hygienic idea was behind it; it was entirely a ceremonial of arrival at man's estate.

In the Wyoming desert there is a monument known as Crow-heart Butte. It was placed there by one of our American Indian tribes to mark the spot where the Crows were finally vanquished in the fight for the Wind River Valley. Such bravery had been shown by the Crows that their opponents opened their bodies after death and extracted the hearts, which were the supposed seats of courage. Thousands of hearts were stewed into a broth and eaten

with the firm conviction that the great strength and bravery of a valiant enemy would pass into the bodies of the conquerors.

To return to the Borneo head-hunters. For centuries, tribesmen have watched their women bring forth offspring and, contemplating the pain and travail, have concluded that to make the circumstances easier they can attract strength to her from outside sources. So, to this day, when a native woman is bearing a child, the husky males gather in a circle and go through the most exhausting ordeals that the strength they lose may go into the woman. The reasoning of the ancients was along similar lines.

And so they had contrived a magic formula to meet every rising evil. They had found from experience that a certain herb possessed purgative qualities and a brew of certain plants had some other medicinal value. Out of magic they had built their various gods—a new god for each emergency, and a series of supervising gods above all the others.

In Egypt the official god of healing was I-En-Hotep, he whose image stood for centuries stonily staring up the Nile. Here he was worshiped and propitiated by all sects.

Man's first thought was of his body and his next of some miraculous way of keeping it intact, of evading disease and prolonging life. So he created gods to protect him from this, that and every thing. And, to this day, he prostrates himself in prayer for the welfare of his physical as well as his spiritual self. The knot tangled so many thousand years ago has never been completely unsnarled.

Bit by bit, as his ascent continued, man collected the scattered bits of millions of years of varied experiment and experience and pieced together a tangible continuity. It was a strange picture, to be sure, with scraps of fact and fiction, bound up in superstition and connected by ambiguous subtitles. But it was a beginning.

Somewhere at the time marked by the Ebers papyrus the first pyramid man thought of passing on to others the written proof of his vainglorious career. He was proud of his survival and he wanted the world to know it without having it garbled by mere oral repetition.

Previously people had learned from one another of ailments and how to treat them. With the exchange of ideas, perhaps with

the very beginning of the exchange of speech, man complained to his fellows of pains and aches. There seems to be little doubt that that very popular sport of discussing symptoms is one of the oldest amusements in the world.

It is recorded that in ancient Babylon the market-place was turned into a hospital, the sick were brought into the square and lay there upon their beds. As the townsfolk passed by, they would stop and inquire about the illness. In some countries this inquiry was deemed an obligation. The invalid, hoping to find some one who had heard of his ailment before, would describe the nature of his malady. The passer-by would listen patiently and try to remember if he had ever heard of anybody similarly afflicted. If he had, he accommodatingly passed on the remedy that had been used and commented on its success. If a certain herb had worked, then the particular patient would try it. If a particular priest had been successful, he was sought out and his services were enlisted. Thus patients peddled their diseases in public, like provender, long before there were doctors and clinics and hospitals.

Mrs. Casey, leaning over a back fence to advise Mrs. Jones what to do for little Johnny's mumps, is merely carrying on a tradition as old as the crumbling idols.

Once these formulas had been established and found successful, they were passed on from people to people. A trader, crossing from Egypt into Greece, would probably carry word of the marvels performed by some strange brew, just as your next-door neighbor recommends a pet patent medicine for your cold.

Then came the era of priest as physician. He not only would administer his medicines, but also would invoke the particular gods presumed to have brought about the trouble, and, if necessary, he would perform a little magic. A very versatile person, he was incapable of defeat. If his patient lived, it was his magic intercession with the gods that made it possible; but if the patient died, then there were demons that could not be driven out and it was the patient's destiny. With such powers, it was inevitable that he should become a dominant figure in the life of the times.

The Ebers papyrus reveals that the early Egyptians had three sources of treatment: a regular physician, the priest of Sekhet, and finally the magician. Sekhet was the goddess whose wrath was

credited with bringing about all human woe, and the priest of Sekhet was the intermediary who appeased her anger. The priest was invariably the first choice, and only when he could not be obtained was a physician consulted. The physician was looked upon as a mere layman with no influence upon the gods. If the illness was apparently a simple indisposition, the patient would content himself with the physician. But if it was serious or obscure, or possibly fatal, he demanded either a priest or a magician.

In a case of fracture, a priest would attempt to set the bone. Generally, however, the doctors arrived with their ponderous books. These contained drawings which naïvely pictured the human frame and were consulted more to impress the patient than to instruct his helpers.

The priests had little more than contempt for the knowledge of the physicians. To quote a passage from the papyrus, "The patient is treated by the physician in an inferior way, but the patient, nevertheless, may recover. The priest does not possess this vulgar instruction, but acts following the direct and entirely personal inspiration that he receives from the gods."

Important links between the present and the days of the pyramids, other than the papyrus, have been provided by the mummies, those amazingly preserved corpses of an early civilization. The mummies have remained through the ages one of man's most ingenious gestures toward immortality, and in a material sense one of the most successful, since physical likenesses and identities have enjoyed a certain deathlessness.

Within recent years, science has produced its Sherlocks to unravel mysteries surviving time's erosive processes of destruction. Some have read for us the story of ancient manners and customs; some have trailed the laws and arts. Sir Marc Armand Ruffur, of London, chose to ask after their health and then to find the answer for himself. He was not the first to make such inquiry—one Fouquet, a Frenchman, pioneered; but Sir Marc left behind him the most comprehensive and informative documents when he died in a shipwreck off Salonika, just a few years ago. His wife, who had assisted him, put his last data in shape and chronicled his discoveries.

As a sanitary engineer, and a famous hygienist, he was sent by

the British government into Egypt at the time of the World War. Working with a distinguished party on the raising of a dam in Nubia, he unearthed hundreds of mummies. Sir Marc would pause in his work to look upon these kinsfolk of the long ago, swathed in their sticky bandages.

He would ask himself: How had they lived? How had they died? Were they subject to the same ills that affect modern mortals? There they lay—kings and subjects! And the same laws of life and death governing both! Sir Marc brought every modern scientific aid to his work. One by one, he unwound the gummy enswathings. He studied every nuance with scholarly intensity. The clews were difficult to follow, and, after all, he could learn only a limited number of things and reach a limited number of conclusions. For the Egyptian embalmers were thorough in the preparation of their dead. They had intended that they should be sacred and safe in death, prepared to pursue death's adventures, perhaps to wander from form to form through many incarnations and some day to return to their own hollow shells—ennobled and enriched, and find them unmolested.

Sir Marc found the tissues hard and brittle, ready to break apart and difficult to handle. He had to soften the mummies in one solution and harden them in another. He discovered that then, as now, men were buried according to their means. There were, apparently, three different embalming processes. After the death of a loved one, relatives would go to those specially appointed for this task and, just as a casket may be bought at a scaled price, they purchased an embalming process, in accordance with their means. Those who paid the highest price enjoyed the knowledge that their deceased had been anointed with rare perfumes and the finest oils and unguents.

Here may be found the answer to Egyptian knowledge of anatomy. In later years the Greeks forbade their dead to be touched. So did the Arabs; and while the Egyptians also viewed their dead as sacred, the very process of immortalizing them gave them a knowledge of the internal body. First the brain was removed, then an incision was made in the side and entrails taken out. Certain arteries and vessels and muscles also were taken. The heart was

generally left and one or more main arteries. Then the mummy was carefully stuffed with processed materials.

In Nubia, Sir Marc studied mummies whose span of life dated back to 1500 B.C. And when he opened a quarantine station at El Tor, he came upon an interesting group of dead. Here had been a short-lived race. Few had lived to be more than fifty years of age and hundreds had passed on in mid-life.

Why? he asked.

Then came a discovery destined to kick a lot of popular notions upstairs. Here, and in scores of other places, he found men had suffered from hardening of the arteries; thousands had been stricken with arthritis or inflammation of the joints. Yet, we have been told, hardening of the arteries is a consequence of modern life. Tobacco, they say, is a great contributor; too much eating and drinking; the rush and bustle of existence; underexercise and overwork; and that dread disease, syphilis.

But here were thousands of victims who had never heard of tobacco and who were not heavy drinkers, who worked little, who ate sparingly of meat and who knew no rush and bustle and, strange to say, showed no signs of syphilitic infection. Bolstering up the findings of Sir Marc were post-mortems on 800 Mussulmans, whose religion forbade drinking. Obviously, new explanations are now necessary.

Sir Marc also carefully examined their teeth. "Four out of five have it" could more truthfully be written of the ancient than of the modern pyorrheacs. Such dental work as was done was largely ornamental. Hundreds of mummies were found with teeth inlaid with pearls or with fancy gold work; but tens of thousands were found who had never heard of a toothbrush, and whose teeth were cleansed only by the rough food they ate. The Copts, for instance, finished their meals by chewing a fibrous material that helped to remove the dental débris.

The destinies of empires have been known to hang upon a hair, but Sir Marc found one that was dissolved in fat. One day he put King Ihnator, son of Amenhotep III, through his scientific third degree and answered an historic riddle. It seems this king had persistently refused to lead his armies against invaders of his provinces and thus had lost valuable possessions, throwing

thousands into slavery. The microscope provided an answer. The sad truth was that the king was a man of considerable circumference. His obesity was such that he would have made a clumsy leader of his troops, and suffering an inferiority complex, not unmingled with vanity, he preferred to remain at home.

Again Sir Marc used the microscope to find the answer to an ancient mystery. King Sahnoura-Tionakin died mysteriously. It was a case for the police had they but known it. But his death was never explained at the time. Thousands of years later, the good king lay upon the slab of the scientist, who discovered that his majesty had met with a violent end, an ax and spear probably having been used to do away with him.

Then there was the tragic case of poor Queen Nofritan whose head refused to be a rendezvous for hair. Sir Marc found that it was not unusual for women as well as men to become bald. They blamed the demons and the gods alike; perhaps they applied salves and oils to their pates "too late to save it." But, alas, the evidence of the microscope is that they had been a bit careless about vermin. In the vernacular, this good royal lady was pedicular.

Sir Marc furthermore investigated the effects of consanguineous marriage as practiced by the Pharaohs. It has been taught that inbreeding in the human family results in weak and deteriorated stock. Sir Marc's report refutes this idea, at least in part. Where the stock was good, the line remained good, when first cousins, aunts and nephews, and even brothers and sisters, married. He has charted whole family trees and examined the family dead, always with the same results.

Why, you ask, did brothers marry sisters? Were they not a terribly degenerate people? Not in the least! The custom, like all customs, grew out of what was considered a social necessity. In those times, royal title inheritances, property and such, descended through the woman of the house. The king could rule the land and hold all the powers of state, but the physical possessions went to the women in the line. Thus a queen who bore a daughter wished to keep the family possessions intact. If she also had a son, the marriage of brother and sister would be arranged to keep the estate undisturbed; otherwise a match with the nearest of kin would be in order. The Ptolemys, for instance,

were a consanguineous family. Such intermarriage was prevalent among many early peoples. Moses, you will recall, was born of a nephew and an aunt; first cousins frequently married, and it even became fashionable in some circles for father and daughter, mother and son, to join in matrimony.

The custom of consanguineous marriage was eventually discarded, especially by Mosaic law, when it had been observed that children born of those of similar germ-plasm showed deterioration and degeneration. It was not until the end of the 19th century that the monk, Mendel, proved to us why this was an inevitable eventuality. Where the birthright is free from stain and stigma, superior creatures will result. But if the slightest stain or stigma is present in one germ-plasm, it will probably be present in cells of kindred origin, and the defects will be multiplied in the issue. Nature likes to renew itself by mingling and mixing varying stocks and it would be a colorless world if this were not so.

Sacred animals, as well as men, were entombed and preserved, each region having a different animal or bird dedicated to some tradition. Throughout most of Egypt the ibis was considered sacred, and in Bubastis the cat held sway. To the ibis there is attached a most singular legend which, in view of the bird's sacred status, is more than likely to have some foundation. Pliny, the Roman historian, narrates that it was the ibis that gave mankind the idea for the internal bath; the ibis it was that inspired the enema!

Since the man who first made the discovery is anonymous and legendary, we will dignify him with the name of Ramtoten, for the purposes of anecdote. Ramtoten was wandering along the river when he espied an ibis standing near the shore. As he approached, he was surprised to note that the bird did not fly away. This seemed odd to him, since every other ibis he had ever seen had taken wing at the slightest sound of a footfall. A more dejected looking ibis he had never seen. The bird tried to leave the ground but couldn't make it. Ramtoten sat down in fascinated perplexity. Suddenly he saw the bird dip its long bill into the water and take a large beakful; then it corkscrewed its long neck backward and turned itself into a living syringe. This was repeated several times

and the internal bath was followed by most effective results. The bird soon recovered from its apathy and flew away.

Ramtoten went home and contrived an instrument fashioned after an ibis' beak, and without much difficulty found a method of connecting it with a water container. Having successfully experimented upon himself, he passed the glad tidings to his friends. One by one they tried out this amazing remedy when sluggishness came upon them. One by one they praised the ibis and called it a heaven-sent bird. And, lo, the ibis became the sacred bird of Egypt.

There is no legend linking the cat with health, but some credit its veneration with the presence of destructive rodents in the grain fields. The cats, being aids to crop welfare, were warmly appreciated. There are other legends that the cat was linked with planetary influence, which, in those days, was given great importance. Any flat-dweller whose sleep has been murdered by the feline choir holding forth on the back-yard fence on a moonlight night, may not see the point, but when the cats of Bubastis howled their mating melodies at the moon, the good people thought that the animals came under lunar influence and were serenading a very important planet. At any rate, the cat was taken very seriously and any one who dared as much as toss a sandal at the sleep-destroyer was made the victim of public indignation. He would be dragged through the streets, and when fanaticism seized the mob, he would be stoned to death. Furthermore, the Kleagles of the Kattish Klan were fed at public expense on a special diet of fish.

It is also recorded that the hippopotamus was held in great horror, was greatly feared, and his ugly likeness was associated with everything terrifying. Yet, Pliny again relates in his compendium of legend and fact, that the hippopotamus taught man the secret of blood letting.

Using our friend Ramtoten once more as the hero of the anecdote, we may suppose the circumstances to have been something like this:

Ramtoten, while on a hunting and fishing trip, came upon one of the dreaded hippopotami. He turned in terror and fled, expecting the animal to charge him, but the hippo did not stir. He wasn't feeling well. He was evidently in no state of mind to do anything that smacked of activity. At a safe distance, Ramtoten hid behind a tree. He watched the huge animal lumbering about in the sharp

reeds that abounded in the quagmire. He heard a splashing and a snorting and soon the river was running red with blood. As he looked over his shoulder, he could see blood flowing from the hippo's legs.

And there you have the Pliny version of man's first lesson in phlebotomy—bloodletting. The hippo would use the sharp reeds as knives, operate on himself, let out a quantity of blood and then stop the bleeding wounds by wallowing in the heavy mud that lay along the river bank.

Pliny, who was a naturalist as well as an historian, compiled the most elaborate accounts of odd theories, bizarre conceptions and peculiar viewpoints on health. Though written after the beginning of the Christian era, his work taps the very springs of myth and magic, legend and law.

He took a great deal for granted and often accepted folk-lore as truth; hence it is difficult to judge just where he abandons fancy and gets down to basic fact.

For instance:—the fox seemed never to tire when running, so bits of fox lungs would be recommended for persons suffering from breathlessness. An antipathy exists between the deer and snakes; therefore one is made immune to snake bite by wearing a deer tooth. A remedy for one bitten is an extract secured from the pregnant womb of a doe.

The root of the wild rose was discovered as a cure for hydrophobia, Pliny goes on to say, by the mother of a soldier who received a warning in her sleep. Again, a soldier hiding from his enemies in a thicket of wild mint, began to chew the leaves to appease his quickening hunger. Thus were the stomachic and carminative properties of mint discovered, to the glory of the julep and the gum.

Vinegar is found mentioned in the very earliest records as an agent for controlling pain. This was probably sour wine with a kick in it. Pliny refers to the anæsthetic qualities of "memphitis" which the ancient Egyptians employed, mixing it with vinegar. The memphitis, he says, was carefully powdered, and, after the creation of the solution, became a local anæsthetic of such potency that the pain suffered was slight. The stone was given a mystical significance, though in the light of modern knowledge the explanation is simple. The stone was doubtless nothing but Memphis marble,

which contains much carbonate of calcium. If it were mixed with vinegar a considerable amount of carbonic acid would be given off, and carbonic acid is recognized as an efficacious "local."

Pliny also mentions many "love potions," aphrodisiacs and odd methods of birth control. Sorcery was employed in the best of families to transfer a disease to one's enemies.

The mole was worshiped by the envying magicians because he could "dig in darkness." The chameleon was credited with all sorts of magic powers, because of its faculty of changing color. Men believed in the curative powers of the anemone, provided one plucked the first blossom of the season and preserved it in red cloth, keeping it always in the shade. If any one suffered from a fever, the cloth was then to be tied about the body.

Magicians invariably conferred occult powers to odd parts of animals and used them as charms. Owls' toes, crabs' eyes, moles' teeth, birds' bills—all were supposed to defend man against disease. It should be added that the crab's eyes, for instance, lost their effectiveness unless the blinded crab was returned to the water before sunset and the eyes themselves hung upon the patient's body.

If one's head happened to be getting bald, the cure lay in plucking the first hair of a new-born male infant. A woman will compromise herself in her sleep if the heart of an owl is applied to her right breast. Pour vinegar on door hinges, save the drippings and you can cure a headache. A hangman's rope tied tightly about the head will give the same result. The dragon knew that the elephant was cold-blooded and hence sought elephant's blood for a summer beverage. The scorpion was seen to eat aconite, become ill and then use wild hellebore as an antidote. Hence men discovered hellebore. Certain animals were seen to prepare for combat on a diet of herbs; the weasel ate rue; an ailing bear went on a diet of ants; animals suffering from snake bites ran at once to certain herbs—

And thus, said Pliny, did man from the very beginning learn a great deal about what to do for himself.

As an example of the reasoning employed by the ancients, the leather medal goes to this one: earth from a cart-wheel rut became an antidote for a certain mouse bite because study had shown the mouse incapable of crossing such a rut.

The milk of a woman who had just given birth to a male child was considered to have great curative powers and if she had delivered twins then her milk was doubly recommended. Female diseases were prevented by wearing the first tooth lost by a male child, provided the tooth had not fallen to the ground. Saliva was associated with all sorts of superstitions. If one expectorated while giving remedies, the cure would be more than certain. To-day we often see Pat and Tony spit on their hands before tackling a job.

Eagles could gaze long at the sun, so their gall became a good eye-salve. The ossifrage had but a single intestine and digested all sorts of things; parts of the bird became weapons against digestive disorders, while the bird's crop, if held in the hand, became a cure for colic.

An uncharitable practice was that of "transferring diseases." Thus, intestinal troubles were supposed to be passed to a puppy if the tiny animal was held against the stomach and fed from the patient's mouth. A duck held against the abdomen would accommodatingly acquire one's cramps. And one could easily pass catarrh to a mule by kissing it. There were some, perhaps, who preferred to keep their catarrh. And, if one were bitten by a scorpion, all that had to be done was to whisper the secret into the ear of an ass and the bite would be passed on.

There was, perhaps, more than mere psychology in the idea of having a beautiful and unadorned virgin recite an incantation while applying a poultice for various inflammations.

Birth control, one learns, was given consideration, and those women whose fecundity seemed to burden them continually were advised to seek out a certain spider, place it in deerskin and be certain to do this just before sunrise. The charm would then work for a year. Loss of virility was undoubtedly a problem, since innumerable phallic charms are suggested. The pregnant woman who eats a shrew-mouse will be blessed with a black-eyed baby. Pig grease contains unusual virtues because the porker eats of herb roots. And seven centipedes mixed with honey will cure asthma.

There are whole volumes of such smile-creating panaceas. But, after all, are they so funny? Many of these have survived down to our own time. Have you already forgotten the chestnut that grandpa stowed in his pocket to keep away rheumatism, or those funny

trick belts people wore for this or that, or the rusty nails and copper wire carried or bound around the wrists? Amber beads are sold to-day not so much for their beauty as for their prophylactic properties. One may not regard with scorn the scapular and the mezuzah.

All nations and all times have had their fetishes and superstitions. In Babylon, the liver was particularly respected, and not without reason. We all know what a sluggish liver will do for a disposition, and in our very time we have heard the expression "How's your liver?" become a phrase of greeting. The early Babylonians, then, looked upon the liver as the seat of all emotions, the palace of the soul itself. And giving it so high a place, the priests at once took to the liver as the seat of divination. One of the earliest anatomical drawings is that of a sheep's liver, divided into many sections, each of which is shown to have certain powers where prophecy is concerned. The magicians used the liver almost exclusively in forecasting everything from the weather to the state of the supplicant's future health. To-day the liver has again come into its own. The cat's supper costs ninety cents a pound just because a number of cases of pernicious anæmia recovered by eating it.

The Chinese had the entire anatomy charted, and conceived the existence of an elaborate caste system in it. To them, the various internal organs were members of a family with the body as their dwelling place. The organs had enemies who attacked them and friends who came to their aid. Each organ was credited with relationship to some season of the year. For instance, the liver, again, was given as head of the family. The heart was his son and the stomach, in turn, was son of the heart. The stomach lives beside its enemy, the kidneys, and its friend, the spleen. The season of the stomach was summer . . . and so on . . . a rather pleasantly imaginative picture on the whole, something like the tales we are wont to spin to children to make them understand their physiology.

That, in a nutshell, is what all early concepts boiled down to: a childlike attempt to interpret all manifestations of nature which men could not understand. Some did it one way; some another, but a similarity underlies the whole, the difference depending upon

the environment, the nature of the people and their basic religious attitudes toward the body, the earth and creation in general.

If Egypt had its I-En-Hotep, India had its Dhanvantari. The Vedas, those Hindu "books of wisdom," preserve for us the folk ways of the Indian ancients.

We learn that fats and butters had great curative powers. The son of Bimbasara, a king, losing consciousness is placed in six tubs of butter, one after another, and finally in a tub of sandalwood, surviving, if you please, to take the throne of his father.

The most ancient Hindu legends show that they recognized how essential it is to achieve a sound mind in a sound body, pure blood and a clean intestinal tract. The legend in the Susruta, their holy book, tells of a terrible scourge that fell upon the land, bringing with it such deadly results that gods and demons alike joined to end it. Thousands of them aided mortals in the gigantic task of churning the ocean so that it would become a huge mass of milk. Milk, to those ancient people, was symbolic of all nutriment. It was the breast food, the source of nutrition for their infants, the sustainer of life. In a unique way, the Indians to this day show how strongly they have been impressed through the centuries by this life symbol. In their caste system, it is ordered that those born to the soldiery shall take two oaths: first, to fight for their country, and second, to defend the cow.

The scourge legend goes on to relate that after many days of churning, there arose from the sea a god of healing who was dressed in white robes somewhat like those worn to-day in the surgical wards of hospitals. And he brought with him nine jewels for mankind. One was pure womanhood—a variation of the Garden of Eden story. In either hand he clasped the symbols which represented health: in the left hand was a leech, the bloodletter, and in his right hand, he held a leaf which was known among Hindus for its potency as a laxative. These symbols are easily interpreted as representing pure blood in a clean body.

Early in the pages of the Susruta appears this paragraph: "Surgery is first and highest in the healing art. It is pure in itself, its use can never die and will be a source of renown on earth to those who practice it."

Small wonder, then, with this "divinely inspired" banner to

guide them, that the Hindus became the greatest of all ancient surgeons. It is known that they invented over a hundred and twenty surgical instruments, from scalpels and lancets to hooks and probes. They seem several times to have just missed important discoveries in anæsthesia, but they had used mild soporifics for centuries.

Since patients underwent their operations with little or no anæsthesia, the surgeons brought speed and dexterity with the knife to a high degree of proficiency. It is recorded that students would be put through a rigid series of trials to test their ability. Stalks of water lilies, veins on large leaves, soft fruits and stems were used for operative experiment—a sort of vegetable vivisection.

The Susruta, being dignified as a most holy book, stressed at great length the value of hygiene. In fact, throughout all ancient life, hygiene is enforced through fear and terror, rather than through any knowledge of its advantages. The leaders recognized hygienic value and knew they could force it upon the masses only through supernatural persuasion. The priests of early Egypt, Babylonia and Assyria used similar methods.

In the Susruta appears this reference to precautionary measures to be observed when traveling in strange lands. "When the king goes forth with his army to fight, he should take with him a learned physician . . . the physician should examine the foods, waters, woods and site of the encampment with greatest care since it is possible the enemy may have poisoned or polluted the waters and spread it upon the ground . . . the king should also take a pious penitent whose prayers will remove all harmful influences. A flag should fly over the physician's tent to show the wounded where he may be found." So—on the first pages of history, do we find the beginnings of cautious organization in sanitation and first aid.

The early Hindus also gained wide repute for their efficiency in plastic surgery, particularly of the nose; some of their methods were used only yesterday. Inquiring into the reason for this proficiency, one learns that in settling arguments of jealousy and enmity, mutilation was most frequently resorted to, and slicing the nose was a favorite method of attack. Erring wives, one finds—or those suspected by husbands—were mutilated that they might never again

appear beautiful to another. With so many cases of this sort coming to them, the physicians became more than usually adept.

As for the ancient Persians, our friend Pliny has reported that their religion was based entirely on healing arts, and concerned with little else. If a Persian wished to practice medicine, he must make his first experimentations on unbelievers and "If three should die under his care, he should be considered incapable"—which is just a bit rough on the unbelievers. "But should he cure three, he shall be qualified to act as physician to the worshipers of Ormuzd."

In the Venidad, a holy book, it is shown that a fee for medical aid was fixed upon by holy writ. Thus, a priest who had received treatment need pay only with a blessing. For treatment of persons of ordinary fortune, the doctor received an ox, the breed of which depended entirely on the circumstances of the patient. If a rich man was treated, "a chariot and four" was the price exacted.

When, then, we come upon the story of Moses, we realize that in proposing his laws which for centuries have been guideposts of a great race, he had both sound and shifting foundations upon which to build. His achievement is not so much one of invention as of adaptation and organization. For Moses was undoubtedly the father of organized sanitation.

Out of the land of Canaan, we are told, there went some 1700 years B.C. six dozen famine-driven folk. They wandered nomadically from the valleys of the Euphrates and Tigris into Egypt. And, so the Bible story goes, they grew into the twelve tribes of Israel, the original branches of the Hebrew family tree whose roots have twisted through every land and civilization, enduring slavery and persecution, plague and combat. Theirs has become the world's classic example of survival.

And how have they survived, and why? It would take many volumes to discuss the many reasons given by students of this subject. One could take the ancient and orthodox preachment that they were the "Chosen People." Poetic and inspiring to be sure, but scarcely a practical explanation! Or one could go into the psychological aspects of the cementing qualities of persecution upon a race who were bound by common woes.

But the essential point to be stressed is this: The Jewish people survived largely because of those hygienic laws of Moses that put

MOSES

Cleanliness on a par with Godliness. The early Hebrews had fathered hygiene which, broadly defined, is nothing more than that "ounce of prevention" which is better than the "pound of cure." While they gave little or nothing to the inventions and ideology of early times, the Hebrews set those standards for precaution and prevention which are the basis of health regulation to this day. They had the world's first organized health department and they enforced their regulations because the rules were grounded in their religious beliefs and to disregard them was an offense to the spirit of Jehovah.

They had acquired considerable experience in their travels. Going from land to land, they had ample opportunity for observing many customs and habits. They had come into Egypt when that land was at a high stage of civilization, had there been thrown into slavery, and forced to accept the foibles of their masters. They were compelled to conform to many changing conditions. So, although their knowledge was largely secondhand and unorganized, their experience taught them the capacity for adjustment; it taught them patience and forbearance and made them acutely attentive to the teaching of such a leader as Moses.

Moses had been given an excellent education in Egypt's "golden age." His teachers had been the priests and it was from them he had learned the lore and wisdom of his time. After he left the Egyptian schools, he had little or no power over the Israelites. The Bible shows his people rejecting him at the end of his training.

He was vexed and chagrined and grieved over the burdens that his people were compelled to bear under the yoke of the Egyptians. And when he avenged the honor of a Hebrew by slaying an Egyptian, he fled before the wrath of Pharaoh to Midian where he dwelt among the shepherds and tended the flocks of Jethro. Here Moses was compelled to go back to first principles. Life presented a new panorama where Nature was its background and where the compulsion of city life no longer influenced the free exercise of his imagination and his genius was permitted to conceive and pronounce the tenets that have ranked him with the great Initiates. Life is a great school and Adversity its greatest teacher. We grow by surmounting difficulties, and our mistakes are blessings if we learn never to make them again.

Here in these peaceful valleys, Moses could follow the flocks and study them. He learned how they ate, how they thrived, how they bred, how they weaned their young, how the best stock was produced, what diseases they had and how they were overcome. Talking with shepherds, he learned what herbs and plants were edible and nutritious. He was getting his information first hand and approaching it with an unbiased intelligence.

He looked in retrospect upon Egypt and remembered the many maladies with which the Egyptians were afflicted. And he recalled that they were loath to keep clean. He saw that all but the lowest beasts appreciated the importance of cleanliness. The cat would sit licking itself and was practically never ill. The flocks would dip into the water and then expose themselves to the sun. There was only the pig who preferred the filth and mire and the stench of his pen to more wholesome surroundings. And he noted that those who ate of its flesh became ill. They frequently suffered excruciating pain, they burned with unusual fever and their eyes were fiery red. There were many other sources of food; why partake of this filthy animal? So he forbade its meat to his people. And he avoided Trichinosis.

Also, he noticed that those who had touched the dead, especially when they had died of continued fevers, were themselves likely to get the disease. So he forbade the touching of the dead and ordered burial within twenty-four hours after the spirit's departure.

Lying upon the hillsides he would ask himself questions—how would he get his people to accept his codes? Suppose he were able to rescue them from Egypt. How could he hold them together? How could he impose his laws? Suppose they said: "Who are you to order us about?" True, he had a great educational advantage over the others, but they would not respect it. If this were an army, and he were a general, it would be different.

Moses must have known what wise men of all time must have known—that the instinct for religion is man's oldest heritage. If Moses intended to impose his laws, it would be necessary to do so under a holy banner. For godliness came first! So to be unclean must be made an offense in the eyes of the deity! The whole code, in fact, would have to be instituted on this basis. If the enforce-

ment of these tenets were placed in the hands of priests, then the people would obey.

So Moses emerged as the generalissimo, surrounded by his corps of Israelite priests—the first health police the world has ever known. And with his plans organized, his will steeled, Moses came back into Egypt with a new determination. He feared nothing now. He had become masterful, unflinching—one of the world's great leaders. He would free his people from the Egyptian yoke! He would lead them back to the land of Canaan! No longer would they be brickmakers to the Egyptian slave-drivers.

Circumstances had been operating to aid his dream. The increasing birth rate among the Israelites had long since begun to alarm the Egyptians. Like the Californians who imported Orientals to do their hard toil in the early days, they awakened suddenly to find the population gaining at an amazing rate. They tried many ways of stopping this growth and finally Egyptian midwives were ordered to dispose of all the male babies by drowning—a fate which Moses, himself, barely escaped, according to the Biblical story. Even this drastic measure failed to give the desired results.

Then, with terrifying suddenness, the ten plagues struck the land. As one disaster followed another, the stricken people looked to heaven for an answer. This must be a demonstration of godly wrath or the curse of some demon upon them. Perhaps those accursed Israelites!

It was a propitious hour for Moses to strike! It gave him an opportunity to act. A terrified nation would doubtless be glad to rid itself of a people who might possibly be visiting this curse upon them! Furthermore, it would aid him in organizing his people, who were thrown into confusion by the hectic aspect of the times. Thus we find him broadcasting the admonition that either they shall obey certain divine laws or they shall be stricken with the dread diseases of Egypt.

The Bible story tells of Aaron's rod and how he smote the earth and one after another the miracles came about. Preparation for these miracles came when Aaron's rod, upon command, produced a serpent. Lore of ancient Egypt shows that this was a common trick among magicians and one that Aaron and Moses might easily have learned from the priests. But when he later smote the earth

and the Nile changed color and out came frogs, lice, and other torments, we must again look for a logical answer.

In the first plague, we are told, the Nile turned blood-red and the fish died. The "plague of waters" it is called. The people cried that the water had turned to blood. The fish died. Cattle drinking it fell ill and the Egyptians feared to drink of it or to bathe in it. Naturally, foul smells rose from the rotting dead and germs bred everywhere. Science has shown that the Nile turns this particular color because of marl deposits upon the bottom, which both pollute and discolor the water. Fish die in it and it becomes unfit for consumption. It is also recorded that seasonal disturbances make the waters of the river dangerous for human use.

The "plague of frogs" was a natural consequence. Driven from their haunts by the condition of the water, the frogs hopped upon land seeking new quarters. They died by the millions and added to the stench and general decay. Flies were certain to gather to enjoy this feast of polluted matter; and beasts, eating of the grass or drinking of the water, would die and eventually wells and crops would be tainted.

Third came the "plague of lice," the consequence of going without baths and neglecting the washing of clothes.

It would have been a miracle had there not been a "plague of flies" and a "murrain of beasts." Fly bites, vermin infection and impoverished blood doubtless were responsible for the "plague of boils." The one unexpected feature was the "plague of hail," which, instead of being a plague, should have been looked upon as a blessing. Coming at the time, however, it probably did seem to be another expression of godly wrath. In fact, the simple failure to understand the very natural causes of the afflictions explains the popular attitude of mind.

Seventh was the "plague of locusts." And eighth was the "plague of darkness," which students to-day attribute to a heavy sandstorm whipped up by hot desert winds,—the sand reaching a density which had the effect of a solar eclipse.

And the "plague of death." Death rode the land with a relentless scythe. Under the circumstances it would have been nothing short of miraculous had it been otherwise. Fear and terror clutched every heart, increasing as each new evil appeared. The

situation must have bordered on hysteria, and those who survived must have been so exhausted physically and psychically that even minor ailments proved fatal against their undermined resistances.

This, then, was the situation in Egypt when Moses took his people in hand and began his historic Exodus—one of the great moments in world history. Starting on his great trek, Moses carried fresh in his mind lessons learned as the plagues of Egypt had progressed.

He had seen the result of dead bodies left to rot. He had confirmed his observations that men die after touching the bodies of the dead. He had seen food turned to poison and water made lethal by contamination.

And he handed to the people, as the word of God, that certain things must be done and others severely avoided. We have no quarrel with the divine source of his inspiration. We know that he was founding the basic rules of hygiene which were to survive through many centuries.

Since they were to travel far and men and women were bound to suffer and fall and perish; and since camps were to be pitched and then deserted, his first regulations covered the immediate emergencies to be met.

These were:
1. Preservation of the water and food.
2. Disposition of all rotting and decomposing material.
3. Care of personal health.

Rigid indeed were the orders concerning infection under the first of these precautionary steps.

The admonition by which cleanliness was enforced in the camps was simply this: "The Lord walketh in thy camp; therefore shall thy camp be holy that he may see no unclean things and turn away from thee."

Where any illness had overtaken one of the nomads, the holy command was that any vessel standing in the room or chancing to touch a dead body would be considered unclean. "It shall be put into water," Moses ordered, "until the seventh day and then it shall be clean. An earthen vessel shall be unclean and ye shall break it and shall not drink from it."

To dispose of refuse, garbage and decomposing materials was

not a simple matter. Sewage was unknown and unthought of, so it was demanded that a "paddle" be part of the equipment of each member of the party. By a "paddle" was meant a digging implement, and all refuse was buried.

And many another program is revealed by a careful reading of the Mosaic lore. In making the necessary sacrifices on the altar, a great deal of the refuse food was incinerated and the ashes carried away and buried. Moses had learned well the lessons of the plagues.

His laws on food were these: "Whatever parteth the hoof and cheweth the cud, that ye shall eat." This allowed cows, oxen, goats, deer and such, and forbade swine, camels, horses, rabbits and so on. The diet laws on fish were: "Whatever hath fins and scales, that shall ye eat." Thus were eliminated clams, oysters, crabs and all shellfish. Doubtless a study of their scavenging habits had been made, or fevers had been traced to them.

Of the birds, "only the clean birds" were allowed as food. Too often had they seen hawks preying over the bodies of the dead and observed crows and vultures feasting on carrion.

But the Mosaic commands do not limit themselves to camp cleanliness and diet; they include elaborate precautions against vice and immorality. It was during a holy war that the matter of venereal diseases reached a crisis. Becoming enamored of the Midian women, tens of thousands were undiscriminating in their sex relationships and diseases spread far and wide. Some 24,000 died as the result. And realizing that fear dominated conscience, Moses pointed out the evils besetting those who were promiscuous in their relationships, warning Israelites against consorting with strange women. Moses not only took up the matter of adultery and wantonness, but passed an edict that all unmarried Midian women who were not virgins should be put to death so that no more disease should be disseminated by them.

In all matters regarding intimate life, he was equally firm. He scorned all forms of sex perversion. Women were compelled to wash carefully after menstruation and to refrain from intercourse during this period.

The ten commandments were but a terse summary of his entire credo. The first sections relating to respect for parents and gods

were not new. Primitive civilizations taught a similar code. Lawmaker, statesman and ruler of this great tribe, Moses naturally prescribed these commands regarding theft, murder, adultery, false witness, and the rest, as he had witnessed the suffering and unhappiness which grew out of their infringements. The text against the graven image was a tenet against phallic worship, which was most prevalent and expressed in hideous and shameless sculpture.

And yet, though all these excellent rules of health and life were known thousands of years ago and practiced, other races did not adopt them, and only with the past century or so did actual hygienic organization get under way.

"Why?" you ask. Recall, first, that the wise books of the Hebrews were written in a tongue little known to most peoples of the time. And, again, do not underestimate the importance of the holy significance given these rules. Elaborate ceremonials have kept many a tenet alive—and conflicting theologies denied even the meritorious missions of alien credos. The children of Israel conformed because their ritual demanded it. They considered every law sanctified and disease was looked upon as punishment from Jehovah.

How simple it is to get away from such traditions of holy purpose may be found in any history of the Jews themselves! Once it was discovered that the basis of the codes was more sanitary than holy, many of their own race grew careless and are to this day. Few of the tenets are now treated reverentially, except among the older orthodox, and modern methods of sanitation, and prophylaxis, have made them unnecessary. But the survival and growth and progress of the Jewish race despite conversion and persecution is not to be attributed so much to their faith and philosophy as to their rules of health and hygiene, which, logically and artfully wedded to their religion, safeguarded their energies and prolonged their lives.

CHAPTER III

Twilight of the Gods

They tell, in the Greek legends, of how Koronis had surrendered her chastity when she met the god, Apollo, and finding herself about to become a mother, fled in shame to the mountain Tithion and there abandoned her child, leaving it to be suckled by a goat and guarded by a dog. At eventide a shepherd came to gather his flocks, and saw the child. And thereupon there occurred such miracles as his eyes had never hoped to behold. Fire was shooting from the infant's mouth and all about was rising smoke and flames.

Such was the birth of Æsculapius, the Greek god of healing. The legend, after all, is not so farfetched when you learn that this was a country filled with healing hot springs. Doubtless more than one shepherd saw "smoke" pouring from the hillsides and valleys. It may even be that some one abandoned a baby there. At any rate, Æsculapius received full credit for all the curative powers of the hot-spring waters and in due season there was built in his honor the historic Temple of Epidaurus, which modern excavators have been able to restore.

The god Apollo, his father, was credited with being the master healer and personal physician to the gods of Olympus. When Æsculapius inherited his father's healing secrets and began to cure men, the business in Hades fell off considerably. Pluto, its guardian, looking over the annual statistics, noticed this decline, and became jealous of his competitor. Doubtless Pluto was quite as proud of his showing as any secretary of an American Chamber of Commerce. He complained to Zeus, who proved quite sympathetic and agreed that such a well-established resort as Hades should not be interfered with.

Zeus removed Æsculapius as painlessly as possible. Mythology says it was merely a matter of smiting him with a thunderbolt.

AESCULAPIUS

But neither Zeus nor Pluto had heard the last of Æsculapius. His name, like John Brown's, went marching on and his following grew until it composed a mighty cult. The day came when this cult, spreading over the lands of the earth, produced minds that saw beyond the gods and, seeing, dethroned them.

Æsculapius had his moment of revenge. His followers eventually disowned Zeus. Gods are something like houses of cards:—if one topples, all are endangered. Æsculapius himself went down with Zeus, Pluto and the rest—but it took many, many years.

And meanwhile, upon the Island of Cos, there had risen that amazing Æsculapian Temple of Epidaurus. Never was there a more ideally located retreat! Here was a place of rolling hills and valleys, heavily wooded and dipping suddenly into a warm sea. Here was a pleasant and kindly climate, pepped with sea breezes and refreshing forest smells, while all about spouted innumerable cleansing mineral springs.

Modern excavators have found how eagerly the priests of the cult leaped upon this spot and how lavishly they prepared it for the comfort, pleasure, and health of those who came to be healed. First there was a ceremonial gateway of imposing proportions. Then appeared a quadrangle, about 250 feet square, surrounded by a colonnade leading to many small rooms. Here, also, was a music hall, and close at hand, an arena for games, ceremonials, dances and plays, equipped with stage and gymnasium. At length came the temple with a huge central shrine on which sat the colossal figure of Æsculapius, a sacred snake in one hand, a dog stretched at his feet. Some twenty-one years were required for the building of this circular temple.

The great artist Pruseas had been commissioned to furnish the murals which faced both patients and worshipers from the temple walls. Pruseas executed two large subjects. The first represented a woman drinking from a huge wine goblet; the other represented Eros, the god of love.

Now since these both appeared in the private sanctum of the god himself, a warning and moral lesson has been read into them. Recall, please, that this was essentially a hot springs resort—perhaps the first in the world! And consider, mayhap, that the world has changed but little. To this day, hot springs are frequented by

those who have looked too often upon the wine-cup, or those who have been indiscreet in their pursuit of the love god. It is not unreasonable to presume that the boys of a far earlier day sought out a spa for similar reasons, and here, pictured before them, was the significant Æsculapian warning.

Upon the walls hung tablets testifying to cures. Each patient was required to relate some wonderful tale of miraculous cure; and this, together with a recitation of his ailment, appeared upon the tablet. The temple containing the greatest number of testimonial tablets won the highest reputation. This was the beginning of the testimonial so popular with the patent medicine propaganda.

Below the temple was the labyrinth for the sacred serpents. These were employed for all holy occasions and were inevitable props in ceremonies for healing of disease. That the serpent should have been selected as a sacred symbol is easily accounted for. The country about Epidaurus abounded in snakes of a yellow-brown species, very large in size and terrifying in appearance, yet quite harmless. Furthermore, they were of a type easily charmed and tamed—and the priests were quite well aware that they were in no danger of being poisoned. They were also well aware of the traditional fear of snakes and were not above using these handy serpents for their priestly hocus-pocus.

A legend that survives the ages gives an interesting example of how the priests used them to benefit themselves and the little corporation they were building up on the Island of Cos. It is told that about 300 B.C., when Rome was still in its youth, a terrible pestilence fell upon the people and death strode up and down the new land. Reports of the wonders of Epidaurus had spread far and wide and a delegation was sent from Rome to implore the Æsculapiads to come to the assistance of the stricken people.

When they arrived, the priests had arranged an impressive ceremonial. They took the delegates directly to the huge image of their god and, as they knelt before him, out from under his feet shot a huge serpent. This spectacular bit of staging greatly impressed the visitors, who stood awe-inspired as they saw the reptile gracefully make its way among the gathering throng and disappear in a holy vase.

The priests at once congratulated the visitors on their good for-

tune, explaining that they should take the serpent with them in the vase, and upon arriving home, place it in a temple to Æsculapius. The story goes that, as the ship was nearing the Island of Tibor, the snake escaped the vase and swam ashore, pointing the way for them. Feeling that this was sacred ground, the delegation at once ordered an Æsculapian Temple built on the spot, and behold, the pestilence soon came to an end. Doubtless it had run its course by that time, but the gullible always believed "post hoc ergo propter hoc,"—that the last circumstance concerned with an event was its motivating factor.

There are innumerable other stories telling of how the priests of Cos built up their strength and, in the course of years, they grew tremendously rich and powerful. Patients who came to Epidaurus and were cured gave freely to the temple and the priests; those who came and were not cured, felt that the gods were unfriendly and gave twice as much to purchase the good will of the deities. Whatever the outcome, the temple and the priests thrived.

Epidaurus gives evidence of having been a most popular and busy resort. In many ways it resembles the modern hot springs hotel. One building seems to have been some sort of hostelry, fitted out with 120 beds in one section, and 180 more beds in what passed for a lower floor. There were seats for 12,000 persons in the stadium, and patients and visitors were regaled with the Greek games and concerts and literary exchange, for there is evidence of a library as well.

No modern institution makes greater demands on cleanliness and hygiene than did this ancient sanitarium of a god. Those who came as patients were given a most rigorous examination. But first they had to be dipped in the sea and thoroughly cleansed. Then they were placed on a diet, and abstinence was forced upon them, while they were internally purged. Various baths were given them. Their clothes were taken from them and were thoroughly fumigated.

Interspersed were preparatory sacrifices and prayers. It was demanded of each new arrival that he tell some miraculous tale of the wonder-working Æsculapius to show that he properly appreciated the powers of the worthy god. It is not improbable that, in order to pass this test, honest folk drew upon their imaginations,

and added interesting chapters to the fabulous legends surrounding the "healer."

After these preliminaries, the patient was now ready for his "incubation sleep," and a nicer psychological situation has seldom been devised throughout time. First, he was placed in the temple to spend a night in the very presence of the god. During the night a priest would slip into the chamber. Since the sleeper's rest was likely to be light, because of the mental state such surroundings would produce upon a superstitious soul, most patients probably were aware of the soft-footed visitor. The priest would enter wearing the disguise of Æsculapius and would begin to recite good advice into the "sleeper's" ear. There were times, of course, when a patient actually slept through the night undisturbed. But whether or not he had heard the mutterings of the priest, he would be called upon in the morning to tell what he had dreamed (thus Herr Freud was anticipated many a century ago) and the priests would go away to interpret the dream. From this dream, and from what they had observed in the patient upon his arrival they would make diagnoses and prescribe a cure.

Seemingly the cures varied little. They consisted, in a general way, of various hot baths, applications of oils and unguents, a complete catharsis, a great deal of mystical maneuvering and sometimes internal remedies.

The cult spread through many lands and had its advocates for many centuries; in fact the Æsculapiads established the medical-priests so firmly that they cornered the "medical market." At one time there were some 300 temples dedicated to the cult. The priests were greatly revered. For as direct agents of the healing gods they went among the people distributing health. This dual rôle of healer and divine missionary never functioned under better auspices, since the temples were always built in the most healthful surroundings, and the rest and recreation were beneficial to every one.

And lest you smile or smirk at the folly and ignorance of a race that produced a Homer and a Plato, and a culture not transcended by our most erudite modern times, you need only recall that within the last two years people were sending drops of blood to California to be subjected to the miraculous intelligence of a well

known quack who diagnosed their diseases, prognosticated their cures and even advised their sentimental lives. And patients by the thousands traveled miles to submit themselves to a machine that electrically answered the mysteries of human discontent and suffering even though the batteries were quite dead. Millions in America to-day make their Wednesday night avowals of marvelous cures and happiness regained, in granite edifices dedicated to a New England lady.

We do not speak lightly of either of these methods of diagnosis and cure to which a great many others can be added, for they all have intelligent followers who faithfully avow the success of their ministration, and it is an undeniable fact that they have their value. Faith that moves mountains may also remove moles. And after all, it is how we feel that matters, and not some Latin name applied to a condition which may be nothing more than transient "rancours in the vessels of our peace." At any rate, those of us who attain the voting age are good bets for the insurance companies. For a small premium, they insure our lives; and the growth of these companies in America, their wealth, their property holding, the hundreds of thousands employed by them, are proof of the fact that the great majority of us are destined to attain the Biblical threescore and ten, in spite of occasional indispositions.

Æsculapius and his sons, Machaon and Podalirius, both physicians, are prominent in the Homeric legends, particularly in the Iliad, where they are shown administering to kings and slaves alike, upon the battlefield. His daughter, Hygeia, has become a household word though forgotten as a goddess.

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Following Æsculapius, and bridging the gap between the ancient period of superstition and a new era of dawning rationalism, there appeared one Pythagoras of Sidon. Like some gigantic colossus he stood with one foot in the confused and tangled wilderness of ignorance, and the other seeking a foothold upon the glowing sands of brighter vision and clearer understanding. Caught thus between two cycles of human evolution, it is natural that he reflected a little of each.

He was perhaps the first militant health reformer. On the one

hand, he was a physician and a philosopher, with his ear attuned to the stern voice of science; on the other, he was priest and magician, slipping back into the morass of magic. He traveled every known land to quench his insatiable thirst for knowledge and applied a remarkable logic to the whys and wherefores of his observations and experiences; yet when he was confronted with a problem that he could not solve, he fled to the oracles for an answer.

Not only did he pause to question the nature of all things and to inquire into the reasons for their being, but he also trained a great number of his pupil followers and inspired them with ideas and ideals that eventually influenced the life and spirit of the ancient Greeks to attain their heights of grandeur and glory. Pythagoras was a thought breeder and though often in error was more important to civilization at his time than the accurate dogmatic scientist of later days.

This is the way it is all supposed to have happened: His very birth was ordained by oracle. His father was Mnemarchus, a wealthy trader. Like all good people of the time, Mnemarchus took no important step without first consulting the gods. One day he found himself at Delphi, with his stock of rings and trinkets. He went to the famous oracle and was told that if he took ship to Syria, accompanied by his wife, he would become father of a son whose wisdom, virtue, and beauty would meet few peers on earth. Joyfully the merchant obeyed the oracle and in the year 590 B.C. Pythagoras was born. The happy father hurried home to the island of Samos and in gratitude built a fine temple to Apollo. Then his chief purpose in life was raising the boy who would fulfill the happy augury.

The whole countryside had heard the story and looked upon this golden-haired lad as a prospective superman. The young Pythagoras soon became aware that extraordinary things were expected of him. He was not of ordinary clay. The praise and benediction of the people were heaped upon him, wherever he went.

He was trained first to physical perfection and, when still in his early teens, he journeyed to the Olympic games and won several important victories. Evidently he was destined to become one of the great athletes of all time. But one night as he was walking

away from the arena, he was attracted by a crowd of people listening to a young soap-box orator, or whatever they called sidewalk speakers of the time. The orator was telling them about the transmigration of souls, of the kinship between all animals and how after death one passed from animal to animal. It was a belief widely held in the Orient . . . it was . . .

But young Pythagoras listened no more. His mind was set. He was on his way. He would go out in the world and find out what all such mystical teachings were about. First, however, his father turned him over to the priests; when he had absorbed all that they had to teach him, he moved on to Egypt. He carried a letter from his king to the king of Egypt, requesting his admission into the sanctum sanctorum of the high priests of that land.

He was little more than eighteen when he set out. And he was intensely serious. Having been personally selected by the gods for greatness, he felt keenly the responsibility resting upon his shoulders. He must learn all things and master all things. A certain self-assurance came with the knowledge of his foreordination. A long life was before him. He could be thorough and take things at a leisurely pace.

Almost his first stop was Miletus, that picturesque little city of the Ionian peninsula on the west coast of Asia Minor, captured by wandering Greek tribes several centuries before the Trojan war. Here he had come to counsel with Thales, the great teacher whose name had been carried far by the tongues of scholars—the man who was to live through time as "the father of philosophy" and "the father of science."

What a different world this was! And how strangely different men's minds were in their functioning here!

A typically eccentric genius, this Thales, when one recalled the priests with their standardized codes of prayers and incantations and formulas! An old fellow, brooding beside the sea on things as remote as the horizon! An odd fellow, who paddled along the seashore in his bare feet, looking out to the point where sky and water met and charting strange maps of the skies and solemnly uttering thoughts that breathed of sacrilege!

Maps and figures everywhere! And old Thales would look out upon the heavens and say, "They are not deities." And he would

look out upon the sea and say, "There is the basis of all things . . ."

But it was in the hands of his pupil, Anaximander, that Pythagoras was placed for a time. Anaximander was an astronomer, a mathematician, a physician, and a philosopher, who laid out the geographical charts for his teacher and who, five centuries before the Christian era, was tapping at the door of evolutionary secrets.

"You have much to learn, my young friend," he may have admonished the young Pythagoras. "And you can do no better than to be guided by Thales. A great philosopher and thinker . . . he taught me much of the skies. He knows that the planets are balls of fire. The people still think they are gods or homes of the gods. We know better—they are of flaming earth." And the good Pythagoras was shocked at what he heard. He fully expected the gods to strike his mentor dead. Then continued Anaximander: "We are trying to learn what things really are, what they are made of, where we come from, and what about this earth we live upon.

"Thales knows, as I know, that these planets about us are guarded by an eternal law and not by a divine spirit. He thinks that water is the basis of all things. And he *would* think that, since he is about the water so much. What he is trying to grasp is that all things have come out of the water, and there it is that I have gone ahead of him. I believe that there are worlds besides this world and that all these worlds evolve and die. I mean there is a perpetual state of birth and death going on all about us."

At such a statement, well might the eyes of the priest-taught Pythagoras come popping from his head.

"I believe," his teacher told him, "that this universe began with an undifferentiated mass and that there came a separation of opposites. Of these opposites all things are made and were made in the beginning. Let me ask you to believe that all life began in the sea and that some things were driven up on the land as the water receded, that these stranded living things gradually adapted themselves to the new conditions. Some lived and some died. Those that lived learned to breathe and move about on the land and became the founders of the earth. Do not let them fool you, my lad—man was not as he is now from the beginning. Study

him at birth and at adolescence and you will see at once that he could not have survived."

In some such manner was the first theory of evolution started by a bright-eyed visionary who saw beyond the gods. And this at a time when Rome was less than a small river-town and all the north of Europe was a vast and savage wilderness. And 500 years were to pass before the Christian era. Then recall, please, that in our very era with all these problems clearly explained, there are still whole sections of the population denying the theory of evolution, considering it a crime to teach it to the young idea, and living by preference in the ignorance of untimed days.

It is an old and monotonous story—this struggle for the plating of bright new ideas upon the dulled old ones. Life is a pendulum that swings with varying speed between the old and the new. That such amazing advances in teaching were possible in that early day was due almost entirely to the physical circumstances of Miletus and the growing tolerance of the Greek attitude. And there lies the clew to that golden day for Greece, which lay just around the corner.

Connecting the mainland of Asia with Europe were those famous island bridges across which traders from Egypt and Babylon and Crete had trekked for many a century. Now the main port of embarkation was this strip of land called Ionia, upon which were such towns as Miletus, Ephesus and Phocæa. From these points the travelers passed in either direction, some headed for Asia and some for Europe. But here they paused and, sometimes, here they stayed. All civilizations mingled and, mingling, sat down to talk things over. It became a crossroads of the world, where ideas as well as wares were exchanged.

Again, it was a wealthy section since it was profitable to be a trade center between nations. The government, being liberal, allowed colonists every freedom. Circumstances were ideal for the building of a great civilization. A true cosmopolitanism existed and so many and varied were the peoples that no one stopped to look very deeply into the whys and wherefores of their beliefs and traditions. They were accepted as fellow human beings. Such an attitude fostered individualism and individualism fostered liberal thought. Ancient dream-inspired worlds were tottering here.

Furthermore, the climate was ideal and throughout most of the year groups could gather in the open for discussion. Conflicting opinions expressed by the many traders who had come from remote parts did much to stimulate these discussions and to adorn them with colorful narratives. Thales himself had been a merchant, with interests in many lands in the Mediterranean. These early thinkers were tradesmen as well as philosophers and in mingling with their fellow men they had acquired a vital curiosity concerning them, concerning life and the seas they crossed and the heavens whose stars directed them.

Those things which vast masses held as established facts they began to pull apart and examine. And therein lay the beginning of science as we know it.

Such was the Miletus into which Pythagoras had come on his way to Egypt. He had absorbed what his teachers had given him, but he had not been converted to any particular school. He still had his letters of recommendation to the Egyptian king. So he went on in the hope of acquiring new ideas, only to find himself thrown back into the magic and incantation of a dying civilization!

It was no simple matter to break into the sacred presence of the priests. Most of their success lay in keeping their followers ignorant of their secrets and mysteries. Theirs was a "great wisdom" and all of their rites and lore and charm and magic were jealously guarded. They kept their priesthoods within the family, passing them on to others of their kin and establishing a sort of feudal line.

Nevertheless Pythagoras finally managed to enter a small anchorite group that dared not disobey the order of the king, though the more strongly intrenched priests of Memphis had openly forbidden him entrance.

Here he heard more concerning the transmigration of souls. He learned the words of mystic chants and he heard of rare herb concoctions, of mutterings to be uttered over the sick and dying, of tricks, artifices, and subterfuges. He also learned of a strange operation called circumcision which they forced him to undergo before entering. Also they subjected him to the most rigid discipline.

In successive years he went on to Babylon, on to India, through

Greece, and finally home to Samos, his head throbbing with the most protean assortment of conflicting information imaginable.

How to coördinate all these different ideas? What was right and what was wrong? And how different people were! How different were lands! Even as they varied in climate, so they varied in habits, customs, morals, and thoughts.

Pythagoras was not long happy in his old home. A despot was ruling and the wanderer could not tolerate his tyranny. He started out again and wound up on the little island of Crotona. Here was the perfect place for an experiment.

For a number of years Crotonians had been engaged in a bitter warfare. They had not fared so well and as a backwash of their privations and suffering had come a wave of loose living. Life there was gay and decadent. Their women were decorated with spangles and gems, their men drank much and gambled more, morals had grown lax and faithlessness of husband and wife was commonplace; there was little respect for the home and family life had almost disappeared.

One is reminded of the conditions that immediately followed the World War. Some modern novelist might find in Crotona an interesting theme in parallels.

At any rate, Pythagoras strode piously into this scene and began to take command. One of the world's first militant reform movements soon got under way. He was given the usual greeting of the reformer. Officials eyed him suspiciously and considered him an intruder seeking their political sinecures. But when they felt his earnestness and sincerity, they were anxious to help him restore law and order, and soon he was running affairs pretty much as he pleased. Within a relatively short time, he had convinced women that they must throw away their shameful baubles; he had restored family life and he had surrounded himself with a small army of the younger generation of rich nobles who cried for knowledge and instruction and begged him to let them join his school.

Solemnly he told these students that they would have to prove their trustworthiness. He had not come upon his learning, he went on, without the strictest discipline. If they really wanted to follow him and learn, they must go through a period of training.

His first demand was a period of two years of intensive study, and during this time they must refrain from all conversation. When this apprenticeship of silence had been served, he would be ready to take them to his arms.

Also he enforced, not only upon them but upon the entire population, a rigid code of hygienic living. First, a long walk in the morning, a breakfast of fruits and breads; no meat at any meals; plenty of honey, vegetables, and fruits; and finally, vigorous exercise. At least one bath a day and various methods of insuring intestinal cleanliness were prescribed.

As his school grew, Pythagoras began to note the germination of ideas among his young men. And when he took his excursions into Greece and Italy he heard of new ideas and brought them home to discuss with the scholars. Many of the old influences of numbers and oracles and magic would necessarily creep into their dissertations.

But, on the other hand, he would tell them:

"Great importance lies, my pupils, in the structure of the body, the functioning of the senses, in mental activity, in the reproduction of your kind and in the treatment of the sick. There is much mystery in the beginning of life. You have all wondered where you came from and how you are formed. I, for one, do not believe the accepted views. I have been making certain studies of the chicken egg. I have watched it at various phases of its growth. I have broken one open on a certain day and another on a later day, and I have seen how the changes come. We grow within the womb very much in the same way."

And so Pythagoras upheld the embryonic theory.

There was a bright pupil, Alcmæon by name. Pythagoras was an old man when Alcmæon came to him and heard the "theory of opposites," as Pythagoras had heard it from Anaximander. Together they would dissect bodies and study anatomy.

One day Alcmæon came, his eyes shining with the light of a great new idea.

"What, my teacher, do you consider the seat of thought? What is the center of human reason and of all higher things?"

"A mighty problem, Alcmæon, and one on which I have long pondered. You know, of course, that some say it is the heart,

and in Babylon they say it is the liver. I have been puzzled more than once. When I was with the priests of Egypt, I have seen them, after deep thinking, hold their hands to their heads and complain of a hurting head. And I have said to myself that it comes from the head. Again, when I was in the Olympic games, I saw a man struck upon the head and all animation left him. And I again said that somewhere in the head is the seat of consciousness!!!"

"Exactly, my teacher. I have thought as much. And it seems to me that in the brain lies the center of all human activity."

Alcmæon lived to announce this belief boldly to the world, and to be credited as the discoverer. Many a century passed, however, before exact science proved the accuracy of his belief.

There were two who had begun to guess at the atomic theory —Democrates and Leucippus by name. Everything, they said, is driven by necessity. New worlds rise and die; planets collide in space and disappear; the universe is a great machine without permanent design. There are only atoms and void, and all things are made of atoms.

You can readily see that many men were appearing who substituted thinking caps for helmets.

The aging Pythagoras heard their stories and pondered. He was too involved between his old gods and his new notions to swing completely one way or the other. On one hand, he would put down such analytical evolutionary thoughts as this: "There may have been a time when the shellfish and the reptile knew no master in the universe. The scepter may yet pass from the hand of man to one who is more perfect."

And, almost in the same breath, he would admonish his followers "to honor and obey the gods and to do nothing that might offend them." This command, together with another urging them to "honor their fathers and mothers," has a striking similarity to the first of the Ten Commandments.

He prided himself on the athletic prowess and physical form and condition of his young men, and Crotona became a name to be conjured with in the Olympic games. Pythagoras himself returned to the great amphitheater once, with the intent of entering,

but he was hailed now as a sage and man of great knowledge, rather than as a competitor.

Watching carefully the diet and exercise of his followers, he wrote down a list of instructions which have undergone slight change through the ages. A glance at any physical culture magazine will recall them.

"In no wise neglect the health of thy body," he began. "Give it food and drink in due amount and such exercise as it needeth. Neither pamper it by too indulgent treatment nor pinch it and bring it low by austere diet. Make carefully your choice of food and exercise that the body shall not become overfat and regulate with great care your time of eating and the quantity eaten."

There you have it—a wise counsel uttered nearly six centuries before the Christian era. Temperance in everything was the basis of his teaching.

In a cult where harmony was so strongly stressed, it was but natural that music would find a place, and music was the one emotional outlet strongly advised. It was in the Pythagorean school that music was used for the healing of the sick, particularly for tired minds and jaded nerves. The lyre was particularly recommended, because of its soft and soothing tones; the flute was heatedly condemned for its noise and was said to rouse vulgar passions. How he would have despised the saxophone!

From these tonal treatments of the ailing, the word "tonic" has come into our medical vocabulary, and from time to time the vogue for "treatment by music" has been revived. Within the past few years, Carnegie Hall, in New York, has been jammed with those who came to hear a young musician play his curative music upon the organ. There are phonograph records of music which is said to affect moping moods. There have been innumerable of these "melodic" cults and cures, but they had their beginning with Pythagoras.

He was, no doubt, the first to build a cult around the idea of a sound mind within a sound body. For the mind, said he, one must have education; for the body he advocated exercise and regulation of habits; for the soul, philosophy.

While this stern decree was founded upon the desire for a

profound asceticism, behind it was the basic Pythagorean concept of what was necessary to health.

In India he had encountered those Brahminical founders who already were stressing the desirability of self-control. And during these long years of study he had rigidly restrained his passions and denied himself any self-indulgence. He had also met thinkers who were dividing all life and matter into well-balanced and co-ordinated basic elements.

So, said Pythagoras, harmony in all things is necessary. It is the basis of health and the cornerstone of conduct.

"To achieve this harmony," he would tell his class of noble young ascetics, "you must avoid breaking the slightest rule of order. All things must be in order. Intemperance in any form breaks the balance—drinking and eating alike. You must consecrate yourself to keeping the forces of body and soul alike in constant harmony. Illness is a lack of harmony and wisdom comes only through discipline of the mind."

The slightest indulgence in even the most innocent passion, such as the expression of great joy, was not to be countenanced for fear of breaking harmonic perfection.

There seems to have been a decided similarity between the Pythagoreans and the Puritan attitudes, the difference lying in the goal: Puritanism inflicts such completely virtuous conduct as a means of attaining Heaven and avoiding the penalty of Purgatory, whereas the Pythagoreans used their moral code for health and mental discipline.

A very wise man—a tyrannical reformer and childlike mystic—what a strange combination! And yet how essentially human! In his rôle of reformer, he quite overemphasized the idea of continence and abstinence, probably because he had learned to sublimate his emotional nature through his varied intellectual interests. A purist—but not a Puritan.

In the end his purism brought his downfall and death. While he enjoyed a great following, there were thousands who eagerly sought to remove him. They waited merely for one hand to rise against him in order to join. They were straining at the bit—impatient to enjoy some of their old freedom.

The opportunity came in a most melodramatic fashion. There

came to his school, seeking entrance, the son of a very wealthy man. After an examination, Pythagoras loftily refused him admission. The young man, said he, had neither the basic intelligence nor the true desire to learn. In fact he was right, but he was quite tactless. The pride-pricked Cyclon started out to avenge the insult. He concocted stories of sedition and treason. He had little trouble getting followers. He gathered a group of roisterers and set fire to the famous Pythagorean home, which had become known far and wide as "The House of Cures." But four escaped, Pythagoras among them. He fled to another land, but his enemies followed him and managed to have him exiled. He became a fugitive upon the earth, meeting persecution wherever he went. Feeling against him spread throughout Greece. Malevolent mobs destroyed his schools.

Terror came upon the old man. He looked to the gods who for no apparent reason had become unfriendly. Everywhere he turned he looked into the faces of his enemies. They did not want new ideas; they frowned upon his reforms.

The end came one day in Metapontum. He had gone to the Temple of Muses there, for communion with the tolerant gods of his youth. He solicited them, calling down wrath upon his enemies. Perhaps, in his troubled mind, he trespassed against their favor. He had dared to look beyond them and into an amazing future. He came out. A crowd had gathered. He could hear them shouting and threatening.

Fear and fatigue overwhelmed him. His flight had left him exhausted. For days he had had neither food nor shelter. His clothes were in rags, his face was white and pinched, his feet were bleeding.

What an ironic ending! He, Pythagoras, for whom the gods had promised so much, now found himself forsaken. He, who had spent most of his life preaching the virtues of proper food, now was dying for lack of it. No shelter was left him except the temple. At least he was safe here. A fever came upon him. He swooned and fell to the floor. At any rate, they could not kill him. They dared not enter the temple to murder. This much was spared him—the gods might strike him dead, but he would not be torn by the mob.

So he died—a terrible, ironic death! The priests found him dead upon the temple floor. He had starved to death—but he had fed his principle to the end.

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Then came, during the following century, two men whose importance lies in the influence they were to have upon the great Hippocrates, who raised the curtain on a new era of thought and practice, the true "father of medicine."

The first was a colorful genius who combined the elements of a thespian, a poet, and a scientist. He was just a bit mad. Empedocles was his name. He came from an aristocratic family of Agrigentum, and had sipped some of the intellectual brew that was infusing the Greek colonies. He reflected, too, that joy of life which became so prominent a feature of later Greek life.

Coming from Sicily, he was looked upon as the successor and follower of Pythagoras. He was trained in medicine, but he leaped many leagues ahead of his Pythagorean schooling. He might have gone even further, but for the fact that he was completely spoiled by his followers, who made so much of him that his ego was overinflated, and he suffered from the delusion that he was brother to the gods themselves. Therefore he bedecked himself in grand purple robes, hung laurel crowns upon his head and wore baubles on his brow and neck. He would go pompously about like a peacock, trailed by his sycophantic following.

He would say to them: "I am immortal to you; look on me no more as mortal."

Such a condition did not rise without reason. When he was still young and living in Sicinus, a number of maladies began to afflict the people. Empedocles, looking about for a reason, ordered a large section of swampy soil to be drained. And since this marshland had been a breeding place for impurities, conditions soon improved. The populace, of course, considered him divinely inspired. To-day, when they drain a Jersey swamp and spray it with kerosene to destroy the pesky mosquitoes, we propitiate no god—but boost Standard Oil.

Upon another occasion when ill health came upon a mountain-bowled little city he ordered a great hole bored through rock so

that the north wind could break through. A healthier climate resulted and again the public was at his feet.

At such peaks, Empedocles would sit down and pour out his feelings in the most arrogantly conceited verse.

Legends began to grow about him. They told of a woman who had fallen into cataleptic sleep and had "been dead for thirty days," and who had been restored. There were many such tales scattered about the cities he visited.

In justice to his sincere moments, it must be said that Empedocles was a zealous and earnest worker. For years he experimented, dissecting goats and other animals to learn how the ear was constructed, and he is credited with discovering the ear's labyrinth. Also he was working on an atomic and evolutionary theory which he expressed in verse, a fragment of which is:

"Fools are they who think that aught can begin which formerly was not,
Or that aught can perish and utterly decay . . .
All is but a mingling and a separation of the mingled
Which are called birth and death by ignorant mortals."

His later days were spent in developing a theory of the natural elements, announcing that in finality all things were but combinations of earth, water, air, and fire. This was a theory upon which, for centuries, were based the elemental ideologies. The four elements he mentioned have been taken to represent heat, cold, dampness, and dryness. This was the theory that most greatly affected Hippocrates . . . but that is another story.

Yet, with all his affectations and mannerisms, he was one of the soundest minds of his time. He stumbled still closer to ideas of evolution, going as far as to maintain that the fittest survive and that nature is ever making trials and experiments until living things become accustomed to their environment and go on living and reproducing. Those unfit for their environment, he pointed out, expire. He was one of the first of the environmentalists.

In the end, Empedocles, either touched by madness or bloated with the thespian's desire for a grand gesture, climbed Etna and threw himself into its crater. It was his fatuous belief that ac-

cording to the best traditions the gods so made their exits into the wings of eternal life. Some one tells an ironic story of the volcano belching forth one of his sandals and forever dispelling the idea of his immortality.

And, as every "pro" has its "anti," mere mention may be made of another, Heraclitus by name, who lived in the Pythagorean time, but held a truly autocratic idea concerning mankind. Accepted tenets fed his contempt. Religious attitudes nauseated him. Images were his pet aversion and finally, after preaching and writing against all cathodoxy, he became a hermit, living in the hills so that he would not have to watch what he considered the ridiculous antics of mankind.

"They fill their bellies like cattle," he wrote, "and 10,000 of them are not worth one man of real value."

He was a sort of early-day Mencken, ridiculing the superficial and the insincere, and referring to predecessors and contemporaries as so shallow that they could not see, or so clogged with dogma that they would not.

"Wisdom is not the knowledge of many things," he would say. "It is the appreciation of fundamentals; it is acceptance of only one word—the truth."

And so he preached a naturalistic philosophy, crying for reason and for rationality.

His words did not fall upon deaf ears. For, as we have seen, upon the Greek Isles there were many to listen.

And they were ready to tread each stepping-stone to progress as it appeared. And so we find many little bridges to that glorious day that was dawning in the West.

CHAPTER IV

The Sun Rises in the West

More than 500 years before the Christian era there was born a genius who was the first in all the millions of elapsed years to glimpse Nature as a reflection of truth and truth as a reflection of Nature. He measured the greatest stride in progress since the ape set forth to become a man. He is the hero of the greatest achievement in the pursuit of health.

This genius was Hippocrates. He was born just as the golden age of Pericles illumined the pages of history. His birthplace was the island of Cos, where the temple of Epidaurus stood as a shrine to the art of healing.

His father was a priest-physician and since it was the custom in Cos to educate its sons as healers, Hippocrates was turned over to the priests to prepare him for his ultimate mission in life. This gave him ample opportunity to observe the strange methods employed by his elders. But, even as a boy, Hippocrates looked beyond the traditional teachings with the glowing eyes of the dreamer and the clear mind of the thinker. He wandered about the lovely island, observing everything he encountered. About him the majestic hills and the stately temples seemed to be monuments of gods and man vying for supremacy. Beauty faced him wherever he turned and he communed with Nature in her various languages, fostering a friendship with the trees, the sea, the sky, and the soothing springs that bubbled from the ground. The presence of all these wonders thrilled him and puzzled him, and when he ran to the temples in a fever of curiosity the word "why" was constantly upon his lips. He soon found that his teachers did not encourage inquiry. Instead of answers they thrust the gospel of tradition upon him, and thought that they had fulfilled their mission in teaching him to accept old faiths to explain new mysteries. But here was a boy who was agnostic to accepted

tenets. Then, too, he had met numbers of Athenians who came to the springs for treatment. They talked of changes in thought in Athens, and of men who were upsetting old notions. Original ideas were exploded there like strings of firecrackers. Hippocrates was fascinated. Athens was not far from Cos. He left home and began to pore into the doctrines of Pythagoras, Empedocles, Heraclitus, Alcmæon and others who had gone just before him. Eventually he was associated in friendly and intellectual intercourse with those other geniuses of his day: Plato, Socrates, Pericles, Aristophanes, and Sophocles and many others who dedicated their lives to art, philosophy, and statesmanship, and created a culture, the glory of which is resplendent to this day. The sun of enlightenment had risen in the West.

When he had left the temples behind, his first teacher was Herodicus, the gymnastic master, who introduced physical cultural methods to healing. Herodicus was the Muldoon of his day. His treatments were severe and rigorous, and it is recorded that he often made his patients take a twenty-mile walk by way of beginning their day. Herodicus attempted to secure health for his patients by bringing them to the point of fatigue through calisthenics, so that they might eliminate the toxins they had been storing in their systems and enjoy refreshing sleep. Fresh air, sunshine, and movement were the chief guns in his arsenal and many of our physical culture cults to-day, pretending the discovery of new truths, really take their origin from this time. Hippocrates stayed at the gymnasium for a short time and made frequent trips to the countries bounding the Black Sea that he might study the lives, environments, and manners of other peoples.

He was now a lean, handsome youth who went about in a loose robe of immaculate white, designed something like the Roman toga, with the little Æsculapian symbol dangling from his throat to identify him with the healing profession. Like all young physicians of his time, he fashioned his beard after that of the healing god. Those who have wondered why for so many years doctors affected beards of various type may find it in this Æsculapian custom.

It was necessary that a doctor look like a doctor no matter how he treated his patients, and it is only within recent memory that doctors have been given to shaving off their beards since

it was found that they were veritable incubators for bacteria. Thus, Hippocrates assumed the trappings and the suits of his profession according to custom, but his ideas in relation to disease were completely antagonistic to everything that preceded him. Guided by an innate and instinctive genius, he took with him to the bedside of the ailing a mind unencumbered by ancient fancies and untrammeled by contemporary fads. He carried no preconceived notions of devils or gods or incantations or magic, but began to study each individual case from an individual viewpoint, observing carefully, differentiating with marvelous discernment and gradually defining those signs which we know to-day as the specific symptoms of disease. The whole history of science is the history of empiricism; observing things as they were and are; then classifying—noting down related instances; recording similarities and kindred effects. Then comes experiment and test and proof or disproof until that which begins as incident becomes hypothesis, and finally a foster-child of fact. With Hippocrates, we have the beginning of Medicine. His orderly notation of exact observation, his painstaking and precise experiments, his accurate knowledge of human ailments, laid the foundation for all future observation and study. And these chroniclings involved much labor since he had to carve his records on great blocks of wax.

An interesting light is thrown upon his mental attitude in the record of his first important case. Hippocrates had been summoned to Macedonia where the young king, Perdiccas, had been suffering from an inexplicable malady. It was a great honor for so young a man to be called to treat a royal patient. The young king was out of sorts. He was tossing around in great restlessness. There was a visible palpitation of his heart. He was apathetic to all questions. He was at times petulant, and at other times depressed. His appetite had gone. He was losing weight. All in all, he must have presented a picture the modern physician would have called a nervous breakdown. Prayers, incantations, and herbs having failed, the magic of the warm sun and the healing springs having been of no avail, other physicians had declared that the king was possessed of demons. But Hippocrates noticed that upon the entrance of one Phila, a former favorite of the king's father, Perdiccas showed an abatement of his symptoms. Hippocrates con-

trived to bring her in as a nurse and left her alone with his patient. To the wonder of all he soon recovered. Hippocrates had gained a vital bit of knowledge. A man could be sick and still have nothing organic the matter with him. This is the first record of the magic of the human touch in the treatment of disease and to-day is the subject matter of libraries of books written in interpretation and elucidation of that great group of maladies, called "Neuroses."

Traveling extensively, he had been quick to observe that different climates leave their stamps upon different peoples. He studied their instincts, their habits, their manners, their diseases and their governments. Thereafter he postulated the revolutionary idea that human lives and manners of living were dominated by climatic conditions.

European ascendency over Asia Minor, he said, was due to a variable climate and varying food. In Asia the climate was mild, the fields very fertile and the people lived largely on a vegetable diet; the government was despotic, the tribes unimaginative and unprogressive. In Europe the climate was more varied. People were compelled to reconcile themselves to its vagaries. Their diet was a mixed one. They were constantly compelled to adapt themselves to the variations produced by the elements and to the caprices of the soil. Europeans were more warlike. They were sturdier. Their government was democratic.

In these travels, Hippocrates came upon several plague-ridden areas and took note that the scourges traveled from one place to another. Why? The unseen and unsensed monster of destruction must go by air since wind currents seemed to predicate the appearance of plagues in these varying places. He happened to be in Illyria, where a pestilence had stricken the people. By way of experiment he studied the direction of the wind. Here was a chance to put his theory to practical application. "This should carry it to Attica," he predicted, and sent a proper warning to the Atticans. The pestilence soon appeared there and the Atticans were able to resist it with all the provisions they knew. Thereafter, Hippocrates found himself linked with the very gods, and small wonder. He was stealing the thunder from the oracles.

Hippocrates did not delude himself. He did not consider himself divinely inspired. He did not warp his vision with arrogant

assumptions of vainglory and conceit. He was looking for natural causes. The forces of Nature were his compatriots. He attuned his ears to their promptings. To Nature he listened for his answers. He summed up his theories something as follows:

"In a state of health, Nature builds and conserves. In illness, she provides healing medication and makes every effort to save life. Survival of all things is Nature's plan and she coöperates in both sickness and health to preserve her creations."

"Nature knows what is best for all living things. Her rules are clear. If a man evades them he suffers, but even where he neglects Nature's laws, she stands ready to help him. Nature gives life to everything; she is providential and seeks to provide for each species what it needs and to prevent that which is harmful."

"Nature has provided most medications and the doctor's task lies chiefly in being of assistance to Nature, supplying necessary remedial agencies and then giving Nature a chance."

"One must take into consideration that Nature is subject to mutation. Just as man changes physically from year to year, so does Nature change almost from hour to hour and that which is beneficial in one season may have the reverse effect at another. So in treating a patient, Nature's particular mood at the time should be studied."

"Each ailment has a morbid cause, and the moment it appears Nature gets out her forces to combat it."

There, in a nutshell, you have the Hippocratic teaching—and it plumbs the very laws of life and health that physicians, during many centuries, had been unable to improve.

It is only within the last century that science, with a surer tread, after painstaking years of investigation, has found that Nature is sometimes unkind and sometimes misdirected, and that the modern physician and surgeon have been able to modify her methods, check her caprices, and hasten her labors. Left alone, many would succumb to Nature's arbitrary methods. But we have learned much as you will read from Nature herself, as Hippocrates has so lucidly emphasized. We have learned to assuage man's ills; we have learned to forestall his afflictions. We have learned to prolong his life and to promote his happiness.

A great many illnesses, Hippocrates taught, could be traced

to water. One should make sure which was pure and which impure. Rain water was best, but must be boiled.

"Stagnant waters are the cause of dysentery and fever," he announced, advising the drainage of brackish ponds.

Many of his counsels fell upon the unheeding ears of a droning world, but, like all great men courageous in the face of apathy and contradiction, he remained steadfast in his opinion and went on with undiminished zeal.

Although his reputation had spread far and wide and he was sought by thousands of patients, he remained somewhat cautious in public. He was aware that he faced many handicaps. People still went to oracles, temples, gods, and soothsayers. Hippocrates was shrewd. He well knew how far he could go with his modern ideas. His own diagnosis sufficed for him. He applied for the first time in the history of medicine those details of examination which include appearance, pulse, respiration, temperature, and a study of the excretions. He realized that to many it was less important to know what ailed them than to find out what the result of their ailment would be. Magicians, prophets, and oracles had educated the public to believe in prophecy, so that prognosis was considered more important than diagnosis. On this subject Hippocrates wrote a very pertinent epithet: "When Death is anticipated, it is well to announce it beforehand." If the patient died, you were a prophet! If he lived, you were a great healer. This safety-first policy was not based so much upon fear as upon necessity. The status of a physician differed from priesthood and magician and had yet to be established. As a pioneer, Hippocrates had to tread cautiously. How little has the modern physician varied from this safeguarding tenet! Hippocrates was no coward. He had reason to be well aware of the dangers run by practitioners of medicine.

This anecdote may serve to illustrate his attitude: At the age of thirty his reputation had already traveled beyond his national border and tales of his miracle workings had reached Persia. A deadly plague, accompanied by fever and convulsions, had been rampant in the land. Artaxerxes, King of Persia, offered Hippocrates a fabulous sum if he would come to attend the stricken. Hippocrates answered: "It would be unworthy of me, as a Greek, thus to aspire to the riches of Persia, which has always been an

enemy of my people." Artaxerxes was wild with rage and sent word to Greece to destroy the insolent upstart who had defied a Persian monarch. This the Greeks would not do, and it was only the unification of the Greek states that prevented war over the refusal of a physician, for patriotic reasons, to respond to a call.

This same independence was put to an equally great test when he challenged the popular notions concerning the nature of epilepsy. Up to this time epilepsy had been looked upon as a sacred disease. How was one to account for the writhings and facial contortions of the sufferer unless the attack could be attributed to the presence of supernatural forces?

Street beggars in Greek days, we are told, were made up largely of lepers and epileptics. It was no uncommon sight to see groveling forms lie in the public places with outstretched palms. They had either just recovered from a fit or were about to have one. The priests had educated the public to believe that these poor mendicants were possessed by evil imps who had been sent to them to voice the displeasure of the gods. Their palms must be crossed with money. Money would soothe and placate the godly wrath. And so a predatory priesthood nursed these poor unfortunates for its own unholy gain. Avarice and greed avail themselves of any means to fill their coffers.

The rational-minded Hippocrates, however, studied these epileptics. He watched their attacks. He noted their intervals. He looked into their causes. He traced their background. "Why," he asked, "if the afflicted individual is inhabited by a demon, does this demon make his appearance only at varying times? Why does he appear in some several times a day and in others only once a year? Or why isn't he continually present?

"A house," said he, "is either tenanted or untenanted. If these people were inhabited by an imp, why did he not make his presence plain at all times? Why did their attacks vary in intensity? Why were they at times aware of the onset, and why did it at times strike them with lightning speed? Why were the good and worthy as well as the evil and dishonest similarly afflicted? Why were the attacks superinduced largely by the evasion of Nature's laws?" Hippocrates questioned the time-honored theory of the cause of

this disease and supplied his own answer: "It is a human ailment and not a supernatural manifestation!"

The sanity of his conclusions seems particularly remarkable when it is remembered that Hippocrates had little opportunity for anatomical experimentation. Whatever his ignorance concerning internal functionings, his observation of the externals was almost uncanny. Thus we find, for instance, the "Hippocratic facies," in which the presence of death is painted in unforgettable phrases—a veritable masterpiece of observation. The facies, it might be explained, is indicative of peritonitis, a complication frequently associated with inflammation of our well-known friend, the appendix.

Hippocrates drew, for all future time, his masterful portrait! "A sharp nose, hollow eyes, collapsed temples; ears cold, contracted; ear lobes turned out; skin about the forehead rough, distended, parched; color of the face green, black, livid, or lead-colored. If the countenance be such at commencing of the disease and if this cannot be accounted for by other symptoms, inquiry must be made whether the patient has not long wanted sleep, whether his bowels have been very loose, whether he has suffered from want of food; and if any of these causes be confessed to, the danger is to be reckoned so far less; and it becomes obvious in the course of a day and a night, whether or not the appearance of the countenance proceeded from these causes. If none of these be said to exist, and if the symptoms do not subside in the aforesaid time, it is to be known for certain that death is at hand." A vivid study in impending dissolution!

Just as clearly, Hippocrates noted the clubbed fingers and incurved nails to be seen in tuberculosis where the disease has been of long standing. He described the "succussion splash," found when there is air as well as fluid in the chest, a condition following rupture of the lungs. The patient must be shaken while the doctor's ear is on the patient's chest. A splashing sound is produced. He noted, too, the fingering of the bed-sheets which marks the approaching end of a fevered patient.

His hazy idea of internal operations is shown in the Hippocratic theory of humors which influenced the medical mind for more than a thousand years. Briefly his idea was that the human body is comprised of four humors: the blood, the phlegm, the yellow and

the black bile. These, he said, corresponded to the four elements (heat, cold, wet, dry), and were affected by the seasons.

Thus, it was reasoned, the season of the yellow bile was summer, since that season "was warm and dry and derived from the liver." Winter was allied with phlegm, "being cold, moist and the humor of the brain." Autumn claimed "black bile which was cold and dry and from the spleen." The blood had an alliance with spring, "a warm and moist humor, originating in the heart."

Obviously, this idea was the outgrowth of similar thoughts expressed by his predecessors, who had held the various elements to consist of air, water, heat, and cold. Hippocrates elaborated on them considerably, however, pointing out the necessity of balance in the humors if good health were to be enjoyed.

When we consider his complete lack of equipment and available material, it becomes doubly remarkable that Hippocrates should have come so close to approximating sound scientific conclusions.

Hippocrates left prodigious volumes of studies on health and disease. As a matter of fact, history is inclined to doubt that Hippocrates wrote all the works which appear under his name. It is said that his students, feeling that he had inspired whatever they set down, kept signing his name to their works for generations afterward.

A great deal of his aphoristic writing was done in his late years when, returning to Cos, he became a great teacher and revolutionized all the old concepts. Completely dissociating medicine from philosophy and theurgy, he crystallized the loose knowledge that prevailed into systematic science.

His declining years were charged with despair for there came to his beloved Greece a period of death and terror.

The great Pericles, practicing democracy in his land even as he preached it, had opened the doors of Athens to all strangers. His great tolerance was no pretense. Greece had marched to the greatest glory in all history under the banner of his influence. The arts had flourished, and the sciences. The philosophers dreamed new worlds and the writers produced prolifically their poems and dramas. All about rose monuments of beauty; the crumbling Parthenon to-day pays tribute to his immortality.

This thrilling chapter had mounted to an heroic climax when . . . out of the East crept the specter of plague.

In throwing open the doors of Athens, Pericles had let in the East, and with the East came the ravages of disease which swept the land and left it weak and staggering.

Curious it is to note how plague rides in when nations and peoples have reached a high point of civilization. And the East, simmering somnolently in its lethargy, has on more than one occasion struck at these rising civilizations, not with arms, but with disease that brings havoc beside which armed hosts are friendly invaders. Thus it was in many parts of Europe when the East came in, and with it one of history's most terrible plagues . . . the Black Death. In our own day, we have had a bitter taste. Out of the war came the scourge of influenza which took its mighty toll. Just so, the plague in Greece swept through Thessaly and Thrace and Athens.

One by one Hippocrates saw his friends stricken and could do little more than sadly shake his head as he went from bedside to bedside. In the main streets of Athens a great fire of pine-wood burnt steadily that the air might be purified, but even as we to-day were impotent before the Spanish Influenza, so was Hippocrates powerless to cope with the unseen fiends of the atmosphere.

Anaximander had died suddenly. Phidias lay near death. The son of the great Pericles had just succumbed. Silenus died before Hippocrates could arrive and then Pericles himself was stricken. He sent Aspasia, his beautiful love-mate, and two of his sons to the country. Hippocrates came to see Pericles. Beside his bed stood the statue of Minerva, chiseled by the greatest sculptor of antiquity, Phidias. Gathered around his bed were Sophocles, who had been his constant companion, Alcibiades and Socrates. In the arms of Socrates, Pericles perished, and with him there passed into history a golden age never again to be paralleled. Hippocrates, greatly saddened, returned to his old home at Cos.

Of all the writings he left, that which in the present day is most widely known is his historic "physician's creed," also called the "Hippocratic Oath." It is the code that guides all men of the medical profession. It is the creed to which they are asked to

subscribe when they set forth to practice. It is a code which all ethical professional men religiously obey.

Briefly, the sections of greatest importance and significance are as follows:

"To please no one will I prescribe a deadly drug, nor give advice which might cause death."

"I will not administer to a woman to perform abortion."

"I will preserve the purity of my life and art."

"In every house I enter, I will come for good only . . . keeping myself from ill-doing and seduction."

"All that may come before my knowledge in the exercise of my profession or outside, which ought not to be spread abroad, I will keep secret and never reveal."

Which is really quite a remarkable round-up of the medical morale for one who came directly out of the chaos and confusion of his times. The Oath, needless to say, is a medical classic.

And so are such pithy Hippocratic aphorisms as:

"Use extreme measures for extreme cases."

"Life is short, but art is long."

Applying his theories of heat and cold, damp and dry, to youth and old age, he said: "Those bodies that grow have much natural heat, therefore requiring stores of food, or else the body is consumed. Old men have little heat and need little food. Old men do not suffer from severe fevers because their bodies are cold."

"The belly is hottest in winter and in spring, hence, greater proportions of food are needed in those seasons. In summer and autumn, people should refrain from overeating, especially of meat."

"When a delirium or raving is appeased by sleep, it is a good sign. When we are hungry, we should rest from labor. They die suddenly who do so often faint and swoon from no apparent cause. Sneezing proceeds from the head when the brain becomes overheated."

"A drink of strong wine putteth away hunger."

"In acute diseases, the prediction of outcome is very uncertain."

"Those who in youth have a moist belly, in old age have it dry; but those dry in youth have a moist belly in old age."

There are hundreds of such amusing and often instructive observations.

A dozen tales are told concerning his death.

Some accounts say that he lived to be 103. A romantic version goes that he finally committed suicide and that his grave became a shrine; that bees swarmed in a niche of his tomb and their honey was believed by the still superstitious people to have great curative power, which, in view of his efforts to deliver them from such buncombe, would be a final irony.

. . . . . .

We cannot leave this period without mentioning briefly one other. . . . Out of the débris of despair and desolation have risen, phœnix-like, some of the most beautiful and enduring structures of civilization: and what structure is more immortal than a human mind when it is gifted with genius and when its influence persuades the minds of future generations to search for truth and beauty? Such a human temple of wisdom was Aristotle, described by Dante in his "Inferno" as "the master of those who know and foremost among those who were introduced to Virgil as the world's most wonderful company."

As the creator of the sciences of comparative anatomy, zoölogy, embryology, botany, and physiology, Aristotle's writings have an eternal interest.

Aristotle lives in the story of health as a second liberator for, whereas Hippocrates tore down the gods and looked clearly at man, Aristotle began the penetration of the human body. He was intensely interested in discovering what made things go round. Since religious attitudes made post-mortem investigations of humans impossible, he had to satisfy himself largely with lower animals, and although error occasionally crept into his observations, it was pardonable under the circumstances.

Again, he upset the ideology of his time by quoting the theory that man and not gods would conquer the world; that man and not idols would be masters.

Aristotle was the child of an Asklepiad, Nicomachus, physician to the father of King Philip. Almost from his toddling days he showed signs of amazing brilliance, and when his life was over he knew practically everything that was to be known at the time. In his adolescent days, Aristotle was called to be tutor to the child of Philip, who was destined to become Alexander the Great and

sigh for more worlds to conquer. The importance of this companionship in relation to our story lies in the fact that Alexander opened to Aristotle every resource of his fortune and kingdom. He gave the young scientist a great botanical and zoölogical garden, and with this claborate experimental station at hand, Aristotle was able to follow an unhampered path in studying plants, animals, and even human beings. He made elaborate studies on the incubation of eggs, dissecting the primitive chicks at varying times in their development and noting the progress of their growth. He pried into the mystery of plant life, of budding seeds, and of all creation.

If he had been familiar with the story of Genesis, it would have made him chuckle, and in fact, in his philosophy, he did shake the common conceptions of beginnings.

Before the time of Aristotle it was assumed that the arteries contained air and the veins blood. He noted that there was a movement from the heart to the vessels and that blood was constantly drawn upon by the organs of the body. He found that the air really was conveyed to the body through the lungs, and he considered the relationship between breathing and circulation and thought that the warm blood was cooled by the inspired air. He contributed the knowledge of the actions of many plants to our modern science of pharmacology, and although he was not a practicing physician, his disciples number among the most illustrious of his generation.

Ancient Greece has been sung by poets as the home of the arts of war and peace. We associate the modern Greek with peanuts, popcorn and posies, but his heritage is the most illustrious of all civilization. The Greece of Hippocrates marked the Western limits of the civilized world. And, whereas the sun that warms us rises in the East, the blazing planet of intellectual development and cultural progress rose in the West and ever Westward let its light fall upon advancing humanity.

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To the island of snakes and superstitions which to-day is linked by us, at least in New York, with the production of policemen and politics, we owe the knowledge of a civilization which, at its very dawn, was in its own way as great and as romantic as those more favorably advertised.

The Celts, who came originally from the East and swept over Greece and Gaul, were the earliest colonizers of ancient Ireland and settled there, brought with them the arts, customs, and laws which were among the most ancient in Europe, dating long before the Christian era.

Their early traditions tell us that medicine and surgery were studied and cultivated to a remarkable degree. Like all the other nations of antiquity, the Irish had their great doctors and among them many who are mentioned as having lived in the dim vistas of unrecorded time. There is one Diancecht, who has been regarded as the Celtic Æsculapius. His name translated means "dominant power." Diancecht was a Druid. The Druids were the priests, physicians, and seers of the ancient Irish civilization, famed for their skill and knowledge. According to ancient chronicle, they were well versed in the book of Nature, knew the marvels of natural magic, the properties of herbs, and the significance of the stars. It is said that some were able to induce others to see and hear according to their wish, so that hypnotism was not unknown to them. In keeping with their present reputation, the ancient Irish were great and valorous fighters, and battles and war punctuate the paragraphs of their progress.

In these battles the Druids played a very significant and important part, taking care of the wounded and restoring them to military fitness. The earliest authentic record of Diancecht's skill is at the battle of Moytura, fought between the Firbolgs and the Tuatha De Danaans, where it is said they prepared a magical bath of herbs and plants into which the wounded were plunged and came out healed. This battle was fought in the year 487 B.C. In this battle the leader, King Nuada, of the race of the Danaans, lost his arm and his physician, Diancecht, staunched the blood and dressed the wound. It is further stated that the King's son, Miach, had an artificial hand, wrought in silver and so exquisitely fashioned and with such mobility in every joint that it was thought natural. The virtue of this hand was a theme for early romantic poetry and even when all fabulous elaboration is granted, we are left with the impression that this early surgical contrivance must have been a remarkable specimen of mechanical artistry.

The art of medicine in those days was handed down from father to son, generation after generation. And where there were no sons, daughters continued in the high and noble profession of their fathers. So highly did they esteem the art of healing and so secretly did they cherish the power that it bestowed upon them, that it is said that Diancecht killed his own son because he was jealous of the superior power he was supposed to possess. The legend continues that there grew up from Miach's grave three hundred and sixty-five herbs, from the three hundred and sixty-five joints and muscles of his body. Each herb possessed the magic virtue of curing diseases of the part from which it grew. Miach's sister, Airmedh, no less skilled than her brother, plucked the herbs and sorted them carefully, but the jealous old father mixed them all up, so that no one could again have knowledge of their distinctive values. Quaintly enough the chronicle states that the "Holy Spirit" would teach the world how to segregate them. And here again we see the intimate relationship between religion and healing.

The value of rest was considerably stressed. It is said of Conner Macnessa, who was King of Ulster at the time of the Incarnation, that he was wounded in the head by a ball from a sling. He was warned to abjure all forms of stress and strain, all violent exercise, and all mental anger or excitement. Having followed these directions for many years, he learned through his oracles of the fate of the Savior, and flew into such a rage that he cut down young saplings with his sword, saying, "If I were there, thus would I have cut down His enemies." The sling shot which had rested peacefully in his skull all these years was dislodged in this fit of anger. It was followed by his brain, and he fell dead upon the spot. Apart from all of the unbelievable incongruity of the recorded legend, the interesting thing is the fact that the King's disobedience of his medical counsel precipitated the catastrophe.

The Book of Lismore further records the illness of Teige of Macken, a Munster prince, who undertook to restore his kingdom to Cormac McArt. A battle was fought at Crinna, and won by the armies of the King of Tara. The prince was badly wounded and, with him, another prince called Luigad-Laga. They were carried to

Tara, but the doctors were induced by Cormac, or his attendants, to poison the wounds of his champions. The method was curious. Small reptiles, portions of poisoned arrows and grains of corn and barley, also poisoned, were secretly placed in the wounds of the invalids. As the poison was intended to work slowly, endeavor was made to heal the wounds over the substances placed in them. Luigad is said to have recovered, due to the fact that his wound opened spontaneously during a vexatious conversation with the King, thus ejecting the poisons. In other words, there was a spontaneous rupture of an abscess and an exudation of its virulent contents, ending in spontaneous recovery. Teige, however, remained sick for a year, until his own medical attendant, Finaa, arrived from Munster with three of his most celebrated disciples. Upon approaching the house they heard the groans of the wounded man.

"What groan is this?" said the physician.

"A groan from a barb," answered the first pupil.

"And what groan is this?" said the physician again.

"A groan from a living reptile," the second pupil said.

"And what groan is this?" the physician said a third time.

"A groan from a poisoned dart," said the third pupil.

Thus did the physician of that day make his diagnosis; and the whole scene may be fitly described as the first clinical lecture on consultation recorded in the Emerald Isle. To continue the story: the physician then entered the house with his disciples. They placed the coulter of a plow in the fire, and blew with the smith's bellows until it was red-hot. One of the pupils then "made a dart at the wound of Teige, and forth came the offending bodies." It seems probable that the assistant in reality reopened the wound with the actual cautery. There are relics in Ireland dating back to the first centuries after Christ that undoubtedly betray a Greek influence and foreshadow our own thermic baths. These are stone huts built near pools of water since the climate was too rigorous for men to expose themselves nakedly to the sun at all times of the year. They erected the hut and built a fire within it. When the stones were hot, the fire was extinguished and the complaining patient placed inside until he was in a profuse perspiration. He was then taken out and plunged into the cold pool. One can well imagine the tonic effect of this treatment.

We employ similar treatment to-day with less primitive paraphernalia, but the benefits of elimination in maintaining health were known to our forefathers long before they were able to read and write.

CHAPTER V

Office Hours in Rome

FROM a mere river-town, Rome had grown gradually to be the Queen of all cities.

Less than four centuries before the Christian era, the besieging Gauls had left her stripped—a miserable little town on the borders of Etruria. About a century thereafter Rome was ruling most of Italy and bringing about its unification. But while she had gained in power and wealth through conquest and successful political administration, Rome had remained a scientific laggard. She was far more willing to absorb than to create, and her rôle became one of dissemination rather than invention. She was nouveau riche, smug and a bit complacent in her new-found luxury. Being thus, Rome accepted change grudgingly.

For six hundred years before the coming of the Greeks, so Pliny tells us, Rome got along very nicely without doctors. Her inhabitants had been like all other primitive peoples; that is, they had household gods for whatever maladies happened to trouble them. Thus, there were three temples dedicated to the goddess Febris, who ruled over Fever. And since certain asphyxiating fumes chanced to rise from the earth in a certain quarter a temple went up to Mephitis, who dominated the world of foul odors and disgusting maladies. Uterina was guardian of the womb and it took a small parade of goddesses to attend to childbirth. So it went!

Those first physicians that came wandering in from Greece were not of the type to inspire confidence in their calling. They were, for the most part, quacks and blunderers, and there were many tales of incredible brutalities at the hands of visiting Greek surgeons. Rome, they say, was not built in a day—neither was she convinced in a year!

It was at the end of the Punic wars, something like 150 years

before the Christian era, that the process of racial transfusions began to bring any noticeable change in habits. This transfusion was achieved through the medium of slaves and hostages. Conquering nations ask no questions of their captives. Doctors, lawyers, merchants, and thieves come wrapped in the same conquestorial bundle. And so was introduced to Rome the unique paradox of slave-physicians. These began their careers in the homes of the rich and powerful. They were soon accepted as members of the households as well as personal attendants of their lords and masters. Naturally, such an arrangement would not be conducive to the advancement of health knowledge, though many were ready to transplant the knowledge of the Greeks into this land of captivity.

The houses of the rich, however, were hornets' nests of intrigue. One powerful clan was plotting against another and families were rent in the mad scramble for power. Soon the medical slaves were being called upon to demean their profession to its lowest level. Every sort of malpractice was demanded of them and they were asked to be parties to every variety of crime. The administration of drugs and poisons to enemies of their master was a favorite practice. They found that these pernicious practices endowed them with a certain power and humanly, or inhumanly, they traded upon their medical cunning.

Looked upon with modern eyes, their position is indeed incongruous. It seems unthinkable that one could be a man of education and former standing and content himself with the social rôle of slave and villain. But it must be remembered that the institution of slavery was a very fountain of strength in ancient civilizations, and was particularly related to Roman ideas of economic welfare, so that almost any profession was open to slaves, since they numbered the major portion of the population.

The slaves, also, were of the same complexion and frequently of the same race as their masters, and in their learning were almost always vastly superior. Since many of them were Greeks, they possessed a basic culture gathered in the homeland before they were captured and pressed into service. And, endowed with the refinement of Greece, they were not in any measure slaves in the ordinary interpretation of the term. They exerted great influence over their masters and in many instances were actually their tutors.

The slave-physician, when he was allowed to practice outside his own household, was forced to turn any fees he received over to his master, and at no time could he acquire any profit or property. Whatever his mental status, he was never allowed to rise above his station of tool of his owner. Because of this unique situation, it becomes apparent why Rome achieved so little in the progress of health. With medicine literally a domestic profession, and almost every man of means equipped with a slave-doctor, there was no particular reason or urge for professional competition, and no glamour or glory to be won by scientific achievement.

A typical instance of the slave-doctor's importance can be gathered from the tale of Democedes, of Crotona, who was a vassal of Oroctes and who had learned much of healing from Pythagoras. One day, King Darius of Persia dislocated his ankle and, quite incidentally, Democedes was called upon to treat it. The slave denied his knowledge of healing lest he be held by the King and not allowed to return home. Democedes loved his native land. Finally, however, threatened with torture, he attended Darius on the promise of being set free. He returned to Crotona, having set the royal ankle, but was returned to slavery. He escaped to Ægina where he opened an office and started practice. His reputation spread too far. Oroctes heard of it and went to Ægina and remanded Democedes to slavery. In the meantime, King Darius had not forgotten the excellent services of the medical slave, and Queen Atossa having been stricken with an abscess of the breast, Darius sent for Democedes. The slave replied that he would treat the Queen if Darius would aid him in escaping his master. Whereupon Darius equipped an expedition, giving orders that Democedes be brought back at any cost. Democedes treated and cured the Queen, but hostility resulted from the expeditionary invasion in his behalf and there ensued a breach between Persia and the Greek state. It is interesting to note the importance of a physician even in the state of slavery, when his services were more important than diplomatic relations.

History offers few more novel or ironic situations. Here were a nouveau-riche people, owning as minions men of high intelligence who secretly had only contempt for their lords. Among the very rich it became the vogue to secure only those Greek

physicians who had been taught by the great masters. Like lackeys to-day, the slaves accompanied their Roman masters wherever they went, and by living for many years with a single family and growing accustomed to its various temperaments, the slaves were able to be family physicians in the truest sense.

There were also a number of freedmen who, though placed by the caste system in the lower classes, became doctors and figured particularly in the imperial courts, frequently marrying into noble houses. The granddaughter of Antony and Cleopatra made such a marriage, and it is told that those who served the princes and members of the senate were fairly showered with riches for their services.

Once Rome had conquered most of the world the circumstances changed somewhat, in that Orientals, particularly the Egyptians, were called upon to treat afflictions, native to the East, which had been brought back by soldiers returning from the wars. Since the Romans were extremely rich, they could afford to send out agents to bring back the best talents of the Orient when various contagions threatened large fractions of the population. The result of this invasion was a veritable orgy of high fees, profiteers fixing the highest prices on imported medications. Like so many parvenu groups, the gold-pursuing Romans held the opinion that the most expensive remedies were of necessity the most desirable and all sorts of unscrupulous flimflamming was resorted to, until it became necessary to pass laws for the protection of rich patients. These laws, however, were so freely violated by the bootleggers from Syria, Egypt, and elsewhere, that it became necessary to appoint an officer whose position corresponded to that of our modern collector of customs. Through this officer had to pass all imported herbs, spices, and other ingredients intended for the medicine chest.

It was during this period that there appeared, perhaps for the first time in recorded history, the woman doctor. Like her brother medico she was a slave and, in most instances, a Greek. In "Sardanapalus," the Byronic tragedy, there appears a quotation which seems admirably to express an immortal attitude toward woman's mission as a ministering angel. We find the Greek slave, Myrrha, speaking thus to her master:

" . . . King, I am your subject!
Master, I am your slave! Man, I have loved you!"

And when Sardanapalus urges her to leave him and find freedom she speaks these eloquent lines:

"The very first
Of human life must spring from woman's breast,
Your first small words are taught you from her lips,
Your first tears quenched by her, and your last sighs
Too often breathed out in a woman's hearing,
When men have shrunk from the ignoble care
Of watching the last hour of him who led them."

Even in her slavery, woman enjoyed greater liberty in Rome than freedom gave her in Greece. Her use in the various households, particularly among those of high station, was to supply antidotes for the poisons administered to members of her master's family through the agency of some other physician. These first women doctors specialized in knowledge of poisons and, since none was safe, thanks to the general corruption in imperial circles, she was a very handy person to have around the house. One of the famous stories of the time concerns the slave Locusta, who was used by the government for handy poisonings, receiving for her grisly services both immunity and profit. Many, however, were engaged in various branches of midwifery and its corollaries.

Of all their practices, the most interesting in the light of to-day was the attention given the sickroom. In fact, they were among the first to comprehend the important influence that the aspect of the bedroom might have upon the state of mind of a patient.

Believing only in the simplest methods, they first concerned themselves with the careful airing of the room. They believed that all diseases had as a common cause the relaxation or constriction of the body's pores, and they invented various methods to secure relaxation. Thus, in cardiac disturbances, where breathing was difficult, they would put the patient in a cool and darkened room and even provided grottoes, the floors of which were covered with the branches of trees and grape leaves, sprinkled from time to

time with cooling water so that the atmosphere might never get muggy.

Attendants sat at the bedside, waving huge palm-leaf fans with which to keep the air continually fresh about the patient's head. This was the forerunner of the oxygen-tank. Great attention was also given the bed itself, a feather mattress being provided where complete relaxation was desired and a very hard one being used when relaxation had been achieved. The amount of covering was dictated by the nature of the ailment. It was changed as the individual recovered or grew worse. Treatment started with three days of fasting, no matter what the condition. Furthermore, certain psychological reactions were desired and the sickroom was carefully prepared to be pleasing to the eye. Various color effects were achieved in the walls, the gray and cream tones predominating, while all pictures and bright colors were erased when it seemed that they might disturb the patient or affect his state of mind.

And when, at its peak of luxury, Rome paused for a moment before her historic slide into the historical gutters, the city could boast of some quite modern conveniences for prospective mothers. It is recorded that the Roman apartments were used by wealthy women, who flocked there from many parts of the world to enjoy a few comforts while bearing children. They were assured baths and commodious quarters, and greater protection against the elements.

In these moments, too, Rome became a most sanitary city, its sewers and aqueducts being famed even to this day. Near by lay the dread menace of marshes, with malaria-breeding environs—and one learns that they used mosquito nets by reading the amusing commentaries thereon of Horace and Juvenal. There was a rule against burial inside the city walls, although this became effective at a time when the city had no physicians. Perhaps a few precautions of this nature made the doctor less necessary.

From all of which it may be seen that the Roman mind ran to the practical.

Shortly after the opening of the Christian era, with Rome teetering between luxury and ruin, the one extraordinary scientific figure of his land and time stepped into this general frame. He was

GALEN

Claudius Galen, a young fellow of roving disposition, whose talents prompted him to follow the sandal paths of Hippocrates.

The modern psychologist, to whom no secret of the soul is sacred, might find in the life of Galen two early influences of particular interest. First, there was his father, Nikon, an architect, with a veritable mania for exactness, nurtured by his interest in mathematics and astronomy. The other was his mother, who is pictured as a veritable Xantippe, and who gave poor Nikon no peace. So henpecked was this honest architect of Pergamus, that he fled at every opportunity from the vicious tongue of his wife and lavished all the affection of a starved life upon his son. The youthful Galen had ample opportunities to study the effect of an ill temper on a sensitive man and to realize how miserable one may be made by a termagant. Into him the unhappy father poured his carefully hoarded store of philosophy, so that as Galen grew up he determined to make life as peaceful and painless an experience as possible. He had vowed never to grieve over such material trifles as poverty or loss of property. Furthermore, his father had driven home to him the precept of "following no party or sect," "despising honors and glory," "listening carefully and judging all sides of a question," and finally, "making truth all-important."

And so, with the search for truth as his watchword, the boy Galen approached his career. Unfortunately, there must have been within him some strains of his mother's disposition, for in spite of all his father had taught him he did become quick of temper, a bit petty and more than a bit arrogant and vain. These pardonable variations from a stable disposition did not, however, deflect him from the pursuit of his mission.

That he was a young man of unusual intelligence is shown by the fact that at fourteen he was studying philosophy, and at seventeen he was beginning the study of medicine, continuing it in Alexandria, Corinth, and Smyrna. Traveling to Rome, he found himself, at the age of twenty-nine, placed in charge of the health of the gladiators, and in attending them he had an excellent opportunity for studying man at his physical best.

Shortly after arriving in Rome, Galen took violent issue with the old line of medical men. A zealous disciple of Hippocrates in addition to nurturing a lust for experiment, Galen achieved a skill

in both diagnosis and treatment that was centuries ahead of the average Roman doctor. He gave public lectures on anatomy and on health in general, developing a very large and fashionable practice. Jealous of his great success, his colleagues became vituperative, and drove him out of the country. A terrible plague succeeded. The orthodox failed to harness it and, after a short absence, Galen returned, this time to serve the Roman emperors who had called upon him when they went forth to fight the invading Germans.

Galen, however, was never bothered by the verbal attacks of his enemies. He was much more affected by praise, for he was exceedingly vain, and, as his early success gained him the attention of Rome's élite, he took on a cocksureness which eventually became a handicap, since it led him to many hasty conclusions, ready-made theories and misconceptions.

He was personal physician to Marcus Aurelius until another epidemic overtook the troops, when he found himself back in Rome as court physician to Marcus' son, Commodus. During his absence his enemies had built a veritable tower of libel, and Galen found himself one of the most unpopular men in the country. Full of bitterness and fighting back with caustic epithets, he finally became completely disgusted and set out to wander about the world.

And in his wanderings, he did a great deal of writing. Much of this early material took the form of a general exposure of the shortcomings of the medical fraternity of Rome. The picture he leaves of them is not pleasant.

In these writings, Galen referred to them as a "band of robbers and rogues with whom gain was the only motive." "There are no real truth seekers in Rome," he said, "all they want is money, power, pleasure, pretense, and display."

With this venomous attitude against the rest of his fellows, it is small wonder that Galen became almost a recluse. He separated himself from the rest of the world, spending most of his time in study and practice. His friends reproached him for being a bookworm and a mental martyr and urged him to mix socially. He became known as an intellectual snob.

This criticism, however, rolled completely off his back and he went on gaining practice and reputation wherever he appeared.

Galen had already been interested in the study of the heart, the arteries and the pulse. He was being greatly vexed by the lack of some instrument which would accurately record the beats. Since watches had not yet been invented and water clocks were about the best the times had to offer, he made many efforts to discover a method of keeping count. In desperation he combined a sun dial with another instrument of his own and in this crude fashion took the first steps toward appreciating the signs of health and illness which a modern physician reads in the variation of heartbeats. He left quite an elaborate record of varying pulse tempos.

Quite as great a handicap as the lack of proper instruments of record, was the law that forbade experimentation on dead bodies. Galen did, however, use monkeys and other animals and, like many of his fellows, fell into serious error by presuming that the anatomical construction of man was absolutely the same as that of the lower animals.

The story is told that Galen once did get hold of the skeleton of a bandit, found washed up from a roadside grave by a severe flood. It is also recorded that mice, reptiles, birds, and fish were being used for experiment, and that upon one occasion a vast crowd gathered to see an elephant cut up. As an indication of the superstitions that still clung to the times, it might be added that the carving of the elephant was not permitted in the interests of science, but was undertaken in order that certain imperial cooks might give their master a dish that would guarantee him the strength and power of the elephant. Galen, however, used the carcass for his own purposes.

In numerous writings, Galen waged an eternal war against the prevalence of superstition and ridiculed those who still adhered to quack practices. He had an eclectic mind and would not identify himself with any of the prevailing schools of medicine.

For instance, his teacher, Pelops, whose knowledge of animal and plant lore was greatly respected, made the rather startling announcement that mad dog bites, snake bites, and other venomous wounds could best be cured by the ashes of the river crab. The logic behind this strange prescription was something like this:—being an aquatic animal, the crab would have a natural enmity towards anything outside its kind. The powers of the river crab are carefully traced

in "The Golden Bough" where it is shown that the good folk believed man could have perpetually renewed his youth, had he limited his diet to the river crabs. This idea was gained from observing that each season the crabs cast off their skins and later appeared to be reborn. By eating of this creature, it was thought that man too would be able to shed his skin and enjoy an annual rebirth. The shedding of the serpent's skin was also taken as a sign of restored youth and there seems to be good evidence that it was not an uncommon practice to put bits of dead vipers into wine as a remedy for all sorts of ills. The tale has been preserved that a young man finding a dead viper in his wine glass became fearful of drinking it and gave it to a man who had been suffering from elephantiasis, thinking to put him out of his misery; instead of which the sufferer enjoyed a miraculous recovery. Still another tale concerns a wife who tried to murder her husband, an invalid, with a similar drink, but succeeded only in curing him. It is not improbable that such tales were circulated by those who feared that their own drinks might be poisoned and felt that stories in which the reverse happened, might prevent any such effort. For all these superstitions, Galen had a profound contempt.

Galen was well versed in the properties of herbs and, being the son of a wealthy man, he was able to procure from all parts of the Orient the very freshest and best of the spices, herbs, and roots which were in great demand for prescriptions. To this may be attributed a great deal of his popularity and success.

As a matter of fact, medical learning of any kind was remunerative in this period, since there was so little of it, and Galen, combining knowledge with an excellent stock of drugs, was in a perfect position to become one of the greatest medical figures of his time. He was particularly persona grata with the emperors, because he could assure them of an unlimited supply of cinnamon, spices, and similar products, which they liked to keep in their cellars very much as the modern American appreciates a cellar full of good alcoholic beverages. There seems to have been no effort too great for him where some rare remedy was concerned. For many years there had come from the mouths of travelers, stories of the wonders of a certain reddish clay known as "terra sigillata" which could be secured only in a certain place near Lemnos. Galen, hearing of

this, made the trip by sea and brought back a sufficient quantity for many hundred pellets. The fabulous nature of this stuff did not end with the Galenic time, but was prevalent up to an almost recent date. Pellets have been found made of this clay and marked with the sacred seal of the Druids. The Druid priestesses were sent specially to gather it, and its marvelous properties were believed to be caused by a strange mixture of the blood of a goat with the earth. Actually it was probably an oxide of iron (hydrate) composition in the soil. However, as late as 1890 there existed reports of its use, and a "soil ceremony" on this spot was performed by Greek monks as late as 1500.

Fundamentally, Galen was trying desperately to find design in nature and, however faulty his conclusions, he was seriously intent on this purpose. He had noted, for instance, how the puppy tries to bite before it has teeth and how the young bulls try to "lock" long before their horns have sprouted. Such indications of the operation of instinct in nature greatly moved this early-day scientist and caused him to write many comments concerning them. He had an almost mystical sense of the perfection of things, and the operation of divine purpose. To-day the study of environment and heredity and evolution explains a great many riddles and problems that perplexed him.

As for Galen's contribution to those things which are generally classified under the heading of "medical knowledge," that which attracted particular attention over a period of time for its originality, was his theory of vitalism. This doctrine held the blood to be endowed with certain "natural spirits" dwelling in the liver, and with vital spirits in the heart. Vital spirits, he held, were converted into animal spirits in the brain. While a bit confusing to the modern mind, his point was that these three spirits supply an explanation of the three faculties existing in the organs where they are formed. The natural faculty being seated in the liver would preside over digestion, nutrition and such; the vital faculty, dwelling in the heart, would supply the body with heat; and the animal faculty, residing in the brain, would govern movement and the emotions, and would be an attribute of almost every human activity.

Here was an attempt to find some explanation for digestion, circulation and mental reaction. The liver was the largest organ

in the body; the heart was the most easily felt, giving evidence of its presence by its endless beating. And the brain, concealed in the cranial cavity, most mysteriously affected the nature of man when it was injured or diseased. In spite of an ignorance which the frown on vivisection fostered, it is interesting to note how nearly right Galen guessed in his materialistic conceptions.

The ancients believed the origins of distempers, pains, and human ills to be resident in the organs which were affected by some discord. The seat of love was put in the heart and this idea has dominated the words of the poets to this day, simply because the heart beats rapidly when a man is emotionally stimulated. By some, the soul was put into the stomach because it is frequently the organ of rebellion when something uncouth or offending affects the human being. The temporary passion of fear produced many symptoms, but particularly a quaking sensation in the abdomen, so that the viscera were regarded as responsible for apprehension and regret.

It is difficult to explain how Galen missed the interpretation of the circulation of the blood. He knew that the valves of the heart determined its direction, but did not consider it a pump, but rather a furnace from which the heat of the body was derived. He knew that arteries contained blood and not air and that the veins and arteries joined in the minute capillaries.

He compared the mode of nutrition to irrigating canals and gardens with a wonderful dispensation by nature that they should neither lack a sufficient quantity of blood for absorption nor be overloaded at any time with excessive supply. He taught that respiration was the introduction of spirit through the lungs to the heart and that the smoky matters derived from the combustion of the blood were discharged by expiration.

Also, he carried on the Hippocratic theory of the four humors, holding that health depends upon the harmony and temperament of these humors; that as long as they are in proper ratio, as long as they are at proper temperature, the individual enjoys health, but as soon as any disorder arises causing them to undergo a change, then ill health results. Out of this grew his own theory of temperaments, the sanguine, phlegmatic, bilious, and melancholic. Other contributions, contained in his gigantic encyclopedia of the knowledge of his time, which included more than forty books on anatomy, physi-

ology, and pathology, and thirty on pharmacy, concern the differentiation of pneumonia from pleurisy, the first prescription of a milk diet and high altitude for tuberculosis, the suggestion of sea voyages for recuperation, and the use of opium, hellebore, and similar drugs for producing anæsthesia. He was also first to describe the sympathetic nervous system, and dilated at length on the use of baths, massage and exercise for treatment of nervous ailments. Singing, he held, was an excellent medium of relaxation and he strongly advised using the voice both in declamation and in song as an aid to lung development. Riding in carriages and litters, he advised, would be likely to prove a mild cathartic. Recalling the springless vehicles and the cobbled pavements of the Roman cities, one can readily realize why such a remedy might prove quite as effective as Galen had stated.

Galen was also a great advocate of bloodletting, but had a tendency to employ it too frequently with exhausting effects upon his patients. Altogether the man was possessed of a great deal of genius, his chief fault seeming to lie in his thirst and appetite for fame which scarcely reflect the true scientific spirit to be found in the example of simplicity and earnestness set by Hippocrates. Time has been the best judge of these faults and virtues, for the centuries have continued to respect the Hippocratic doctrines and virtually to destroy the entire Galenic theory of treatment. It is for his audacious, brilliant, and ingenious mind and his radical expressions of opinion that Galen is best remembered.

In his system of handling patients, Galen made his one contribution which has stood the test of time. Before undertaking treatment of a disease, he would carefully weigh the circumstances under which it developed; and from this would deduce what treatment was indicated. He gave consideration to the age, sex, and general temper of his patient, going into his habits and his general integrity of body and mind. He stressed the importance of considering which organ was involved, and considered the brain, heart and lungs to be the most important. This, in a general way, reflects our own attitude toward disease. He took the first clinical history—as we know it.

Being a great student himself, Galen preached that one should eat moderately after long hours of study, should take walks in the

open air, use cool baths, and stick to food that is easily digested.

Galen was to a great degree responsible for the excellent aqueducts that brought Rome her water supply and the wonderful system of drainage that kept the city sweet and clean. He would probably smile in scorn at the water supply of many of our smaller cities, considering them far inferior by Roman standards. And this not without cause since the lightness in structure and the durability of the Roman conduits have been marveled at by modern engineers.

All of his systems attracted such great favor that they were used in Europe, Asia, and Africa for many centuries. He ruled as a medical Pope until the daring spirits of the Renaissance began to question his infallibility. Nevertheless, it is still a great compliment to a physician to refer to him as a "Galen."

CHAPTER VI

Oasis

SLOWLY stagnation had crept over Europe.

The Greek states, spent by years of warfare, tumbled into decline. Hannibal, dedicated from his cradle to the destruction of Rome, had carried the power of Carthage over the Alps only to drop it just outside the Roman gates at a time when it seemed that only a gentle tap would send them crashing. After that, with Carthage beneath her thumb and the riches of many realms in her pocket, Rome went into the historic debauch that rendered her a reliquary. In another part of the world the learned Egyptian capital at Alexandria had felt the fiery hand of the invader. A young and growing cult of Christians was being heard from, but its fanfares were religious rather than scientific. Its Messiah could heal by the laying on of hands, their prophets said. The soporific influence of mystical teachings was beginning to send all but religious zeal into a long slumber. The dark ages were creeping in.

How, then, was the health knowledge of Greece to survive! Who would carry on where Hippocrates, Galen, and the rest had left off? Who would even preserve such learning as had been acquired?

Not Greece, not Rome, not Egypt! The situation seemed desperately discouraging. The very seats of cultural development were displaying every symptom of dull-mindedness. Out from the cellars and garrets were coming again the amulets and charms. Out of dark alleys, old superstitions were appearing in new clothes. Cobwebbed and dusty magic practices were being revived to suit the changing times. It seemed certain that all accomplished in the interest of human welfare and human progress must be lost.

But one of history's romantic accidents waited round the corner to upset this pessimistic program.

To begin with, there was a certain Nestorius, priest of a Christian sect who had been sent as patriarch to Constantinople. But

he held certain beliefs which others of his faith branded as heresy. He said, for instance, that Mary should not be styled "the Mother of God," but rather "the Mother of Jesus." And for these preachments, Nestorius and his followers were persecuted and driven out into the desert.

Like so many other persecuted people, their differences of opinion indicated a rebellious intelligence that would not tolerate the narrow confines of the beaten path. For this was a group steeped in the Hellenic cultures, a band of students who had been greatly impressed by the teachings of the illustrious and learned Greeks.

They were seeds, blown by an unfavoring wind into more congenial soil. Wandering about over the desert, they came first to Mesopotamia where they dedicated themselves to the work of healing by opening two hospitals at Edessa. They did not mix well and were driven out by Bishop Cyrus. Moving on to Persia they opened their historic school at Gunde-Shapur.

There were other seeds flying in the wind: Persians, Arabians, and Jews of Asia Minor who had come in contact with Greek teachings in Alexandria, where much of the Greek wisdom had been carried by those Athenians whom Justinian I was pleased to call the "heathen philosophers." Driven out of Athens, they had drifted to Alexandria. There had also been an earlier exchange of information and knowledge between the schools of Greece and Egypt which seeped into other sections of the Orient by way of Alexandria. Always was the quest for health and the art of healing of paramount concern. And so the persecuted of many places met in another corner of the world to swap notes. They were determined to keep alive that which had taken so long to piece together. Even then they might not have succeeded. Sympathetic backing was required. This came from a least expected quarter—the dry sands of the desert—the Arabs!

Now the average man on the street thinks of the Arabs in terms of cigarette ads, movie sheiks, camels and tents, whereas the fact is that the Arab was responsible for an era which in many respects was not only one of the brightest in all history, but also one of the most creative. While Europe was allowing its intellectual fires to flicker and burn out in theological controversies, the Arabs were beginning to carry bright torches of learning wherever they went.

Offering safe harbor to thinkers, whatever their race or creed, they drew over their borders the best minds of many peoples and, working together in toleration and encouragement, they translated and classified all of importance left behind by the Greeks. But that is getting a bit ahead of the story!

Over the deserts, for many a generation, had roved wild and restless Arab tribes. They were not, as is generally supposed, an ignorant, worthless people. The circumstances of life made these wanderers of the sand alert, inventive, and self-reliant. And then came the prophet Mahomet!

At his call, they organized as one man, riding forth under the banner of Islam to conquer the world. Their unification was shrewdly aided by the creation of desert states, each dominated by a ruler who organized the nomads into social and military units. Thus they became soldiers of an amazing army that spread the power of Islam from the Indus to the Atlantic. Removed from their desert homes, thrust into new scenes and among new peoples, their horizon was greatly broadened and their status of life greatly changed.

With their conquering sweep across Spain and the subsequent rise of the brilliant, colorful and magnanimous Caliphs who ruled over the Spanish states, the story of health takes a new and vital stride forward. The pivotal points in this new cultural spread were Cordova and Toledo in Spain and Bagdad in the Orient. These caliphates sustained by Mahomet's influence rose to their greatest power after his death.

Though Mahomet may be accused of perpetuating an ignorance of human anatomy, and fostering a fanatical and fatalistic allegiance among his followers, yet he encouraged an interest in scientific thought.

Among his messages, for instance, were these:

"He who desires knowledge adores God; when he spreads it he gives alms; he who possesses it becomes the object of veneration."

"Science protects from sin and error; it lights the road to paradise; it guides through the pains and pleasures of life; the memorials of the wise alone endure; their great deeds stand as models."

"Science is a remedy for the infirmities of ignorance, a com-

forting beacon in the night of injustice; the teaching of it has the value of a prayer and its study the value of a fact."

Did ever a leader, religious or civil, leave wiser counsel for his people?

Then, too, there were lengthy admonitions on cleanliness, reminiscent of the Mosaic teachings. Relationship of cleanliness to health was stressed and where disease itself was concerned Mahomet taught: "God has not inflicted diseases upon us, without at the same time supplying remedies."

Since Allah had provided a remedy why not go in search of it? So many of the faithful set about to see what might be found.

And there was still one more prod to their zeal. The Koran plainly ordained that, "He who restores the life of one man shall be accounted as though he had restored life to humanity."

In the final analysis, the good Moslem allowed no intrusion upon his prophet's teachings but, following Mahomet's death and the rise of the caliphates, the general attitude was liberal and the time came, and soon, when Spain saw a golden age which can match its turrets with the pilasters of Pericles.

In Cordova every boy and girl of twelve was taught to read and write, and in Bagdad the population grew to a point which would have caused a modern Chamber of Commerce to grow boastful in the *Saturday Evening Post*. There were dozens of hospitals, public and private. Students were busily setting down the Greek works and there was a general zest for study. In Bagdad, there were 6,000 students, at one time, in medical colleges.

The most severe blow to research lay in the Mahometan regulation against touching the dead body. This halted, to a large extent, the study of anatomy. There are, however, records that some used apes for experiment.

Conquest had made many very rich families and they acted very much as millionaires do to-day. They began to gather libraries and buy up the latest achievements of the translators. These sold literally for their weight in gold. Furthermore, the rich also began to make generous gifts to be used for scientific advance. Some slight misgiving, or qualm of conscience, caused many a contribution that was expected by its giver to pave his way toward eternal bliss.

To maintain their health, these rich folk paid most splendid fees. It is recorded that one Abu Nasr received $60,000 for some treatment given a Caliph. The well-known Haroun-al-Raschid was in the habit of paying $1,500 for a single bloodletting with, perhaps, a purging thrown in. And who knows but that history's most fabulous fee went into the purse of one Batishua, personal physician to Haroun, who is said to have been given something like $125,000 for attending a certain Al-Maiamun. This medico, at the time of his death, was purported to have amassed ten million dollars.

The Arabian physicians were not without their trickeries. It must be remembered that at this early stage, patients still demanded considerable hocus-pocus with the business of being treated. Even to-day, advertising quacks depend much more upon machinery than upon brains, and a large percentage of the population is more impressed by a physician's office equipment than by the unseen deliberations of diagnostic skill. Fakery asserted itself in many ways, purely as an effort to mystify the patient. It was not enough that he be diagnosed and treated . . . a little sleight-of-hand had to be thrown in for good measure. Invisible ink was a favorite device of the Arab medico for bamboozling his patients.

At the same time, serious students were delving into a wide assortment of problems. Some studied mathematics and developed algebra. Others studied chemicals and brought forth alcohol. Both alcohol and algebra are Arab words, as are also alkali, alchemy and many others of the "al" family. Inventors were producing improvements, such as street lamps and window panes. The dinner table was garnished with syrups, rare spices, condiments of various sorts and a vast array of other tasty foods, while still another group perfected rare perfumes. Let us not forget that we owe our morning coffee to the inquisitiveness of the Arabian investigators. The story is told that an Arab herdsman, imbued with the scientific spirit of the times, observed his goats eating of a small shrub that grew wild in the fertile hinterlands of the desert, and that the goats so feeding were prankier and livelier than those that did not partake of the plant. Investigation and emulation gave the Arab his coffee and the caffeine, which we know to be an excellent stimulant.

Under the light of the "Crescent," civilization was slowly being

guided to await a more resplendent dawn. But to return to Gunde-Shapur, a city on the Persian border. It had been founded by Shapur I who had sacked Antioch and rebuilt it and called it "greater than Antioch" or "Gunde-Shapur," after he had taken the emperor Valerian captive. To this city the Nestorians came. A Christian sect in a Moslem city, they were nevertheless given every opportunity for self-expression. Since the state of the human being in health and disease was their chief concern, they soon built a hospital and made every effort to carry out the teachings of Hippocrates and Galen and to add such new systems and methods as experience had proved. But like so many persecuted people who find final security in opportunity, they soon proceeded to abuse their privileges, developed an unbecoming vainglory and grew intolerant of ideas that differed from their own. So has bigotry ever beset the way of progress.

It so happened that there came to their door one day a certain Hunyan Ibn Ishy, the son of a pharmacist of Hira, a young fellow of intellectual tendencies who had steeped himself in Greek poetry, philosophy, and science so that he was intimately conversant with Hellenic genius. He had hoped to get some practical experience in the hospital of the Nestorians. He had espoused Christianity and as a Christian, felt that this cult would welcome him. But even as our modern hospitals have a sectarian flavor, so did this ancient one. And he found himself rejected. Like the old priests the Nestorians coveted their knowledge and wanted to keep it as their own secret. The door was slammed in his face. But genius has ever been able to crash the gates of opposition. In great disappointment, Hunyan wandered about the streets and recited Arabic translations of the Homeric tales to small groups who would gather about him. So interesting and entertaining were his recitations that the Nestorians who had repudiated him descended from their high horses and accepted him among them, giving him every opportunity for study.

Hunyan soon became a teacher in the Nestorian school and continued his task of translating the famous works of antiquity into both Syriac and Arabic. He began with Hippocrates and Galen and soon followed with the works of other scientists and teachers. Little by little more complete translations were added and were

circulated through all the great cities under the Arabian yoke until in due course of time a great cultural wave swept with Islam in its continued march forward.

As for Hunyan, his fame spread and came to the attention of one of the Caliphs. Shortly after he had arrived as medical adviser, the Caliph ordered him to concoct a poison brew. Hunyan refused, commenting, "I am skilled only in what helps or benefits man. It is not the purpose of a healer to kill." The Caliph gave him his choice between execution and high reward, but Hunyan still refused, whereupon he was thrown into prison for a year. When, at the end of the year, he was still firm in his refusal, the Caliph sent for him, explaining that the whole episode had been staged as a test of trustworthiness and, having proved himself, Hunyan would now become the court physician.

Thereafter he was able to apply himself to study and to continue his translations. Thus romantically began the preservation of Hellenic knowledge, and thus an ironic eventuality restored it to the Europeans. The despised infidel was the custodian of the culture of the Western world, which might otherwise have perished.

Once the impetus had been given, avid and brilliant young students eagerly partook of the cultural feast. Here and there, over the Arab realms, appeared first one genius and then another. There was the gifted young Avenzoar, whose family had produced physicians for more than a century and who went to prison after a clash with the accepted viewpoints. It was a fortunate imprisonment since his cellmate was an elderly man, suffering from a malady of most peculiar nature. Then the prison bars disappeared as far as he was concerned, and the cell became a laboratory in which a young scientist was making first one experiment and then another. When Avenzoar left the jail, he carried with him the first description the world had ever had of how stomach cancer affects its victims. He became interested thereafter in abdominal surgery and championed it as a life-saving measure. Had the world listened to him, it might have made far more rapid medical advances. For Avenzoar refused to swallow the Galenic teachings "whole," pleading against their dogmatism and urging careful inquiry. He found listeners, but no one did anything about it. Galen's confused notions carried on.

Then there was the agnostic young Averroës, who came under the spell of Aristotle's pantheistic teachings. A court physician to the Caliphs, a judge at Cordova and Seville, he frowned upon Mahometanism and finally forsaking it, announced himself a believer in nature—even as Aristotle. With fiery vigor he championed philosophy, as against religion. He declared the idea of personal immortality to be ridiculous and since, under the Mahometan tenets, the belief in immortality was absolute, he was persecuted and deported to Lacena, a large Jewish settlement. But he had started an Aristotelian cult which went secretly about its activities. For centuries his writings made converts and instigated bitter discussion.

And, if you wish a bit of sheer movie melodrama with your science, there is the exciting story of Avicenna, or Ibn Sina in the Arabic. No hero of adventurous romance can claim a more intimate experience with hazard and chance than this gifted Saracen, who left behind him the "Canon," an enormous volume of encyclopedic proportion, which served as a guide book for more than five centuries.

Avicenna was a prodigy. Had he been born to-day he would have immediately attracted the attention of the Winifred Stoner League for Fostering Genius. At ten he could recite many of the classics from beginning to end. At sixteen he was a master of jurisprudence, natural science and logic. At eighteen he was established in practice as a physician, and given the use of the royal library—a most magnificent compliment to his talents.

He grew so studious that he resented the idea of sleep and began to contrive means for keeping awake. He would brew himself various potions and solutions, drinking them continually through the night hours while he continued his labors. His precocity attracted wide interest and he came into great demand in court circles. His young head was turned by all the attentions and flatteries, and soon he slipped into a gay and roistering life. The abandon with which he sowed his wild oats was equaled only by the zeal that he put into his more serious moments. He was on rather intimate terms with the wine cup, and his amatory adventures would put many a thrilling moment into a modern scenario. During this time he broke frequently into verse and left many poems of more than passing quality. When the pendulum of life began to swing

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away from its banalities and pleasures and pointed to sterner moods, he found that the unconventionalities with which he had surrounded himself had fostered radical and even heretical opinions.

These he announced with no respect for the tenets of tradition. Thereupon he was seized and sent to prison on charges of sedition. Up to this time he had enjoyed the protection of a powerful caliph whose personal physician he had been. While he was serving his sentence, the caliph died and Avicenna became fearful lest he would be put to death.

He made his escape, finding refuge in the house of an apothecary. There he devoted himself, while in hiding, to research. Eventually he was found, again escaped the law and, recaptured, was thrown into the Castle of Berdawa. Friends smuggled to his cell the habit of a monk, and so disguised he was again able to gain freedom. This time he found harbor with a friendly caliph in a small town where he continued his work and carried on his practice. His prison terms had offered him opportunity for a great deal of work and thought. Now he was able to organize it all and put it into shape. The combination of all his talents won him immortal recognition under the title of "prince of physicians," which seems to be a most apt appellation. He left behind a vast amount of new information on the nervous system, an analysis of meningitis and many studies of gastric conditions, dysentery, human excretions, the liver, spleen, and gall bladder. However archaic his researches may seem to the modern medical mind, they were extremely valuable to their time, and to those who followed this Arab wonder-man.

His most amazing work, previously mentioned, has become known as "Avicenna's Canon"; in this may be found dissertations on practically all bodily ills known at the time, and a complete compendium of the entire knowledge of his day. Many diseases whose identification we accredit to modern discovery, were clinically known to him, and clearly described.

Medicine was making rapid strides especially in botany and the study of herbs. Every plant growing in the then known world was put to physiological test in the form of brew and extract and, as animal experimentation was unknown, the doctors themselves were the "dogs that the new was tried on." One of the greatest

of the physicians of the time said that no medicine should be given a patient until the doctor had ascertained its merits and its evils by a personal test. To this day the food of Oriental potentates is tasted by some servant before the master partakes of it. A great deal of empiricism was still included in the new pharmacy. Old methods, old remedies, were mixed with the new, so that a prescription contained not only the specific drugs of the physician but all of the nostrums of grandmothers, and great-grandmothers, until it read like an incantation from Macbeth.

Finally we come to that last of the great Arabians—Moses Maimonides. Maimonides would have been important had he done nothing more than collect and translate the thoughts and conclusions of others. He would have been celebrated had he done nothing more than assemble the hygienic laws of his race, handed down from Moses—but to these he added practical ideas of application which might well have issued from a modern board of health. He would also have won immediate and future recognition for his methods—however abstruse they may seem to us to-day—of treating the sick.

But, in addition to all these, he compiled a dozen works; made personal translations of the Greek physicians; and in his "Guide to the Perplexed" foreshadowed the modern clash between science and religion which reached its climax at Dayton, Tennessee. In a day when the glittering Arabian world began to sway and totter under the ravages of uncouth desert hordes, Moses Maimonides was trying to reconcile the scientific to the philosophic and the religious. He was trying to lead the masses out of the perplexity arising from conflict between what their priests told them and what their groping scientists were suspecting; he was seeking to clarify a scene which confuses many to this very day.

The genius of the man is best appreciated when one tries to visualize the times and conditions in which his life was cast. Few gasps of surprise follow announcements of discovery in a modern laboratory.

Get back for a moment to the year 1135 when, in the city of Cordova, Spain, Maimonides was born! He had come of a distinguished family, whose line was credited with running back to the

Biblical David. His father was a scholar and provided him with a background of culture and refinement.

But Cordova was in decline. The golden age of Arab culture, with its tolerance of all arts and talents, had begun to wane. Almost half a century earlier the caliph of Cordova had called upon the Berbers, a fanatic desert tribe, to help battle the Spaniards on the north. Even in its happiest moments, all was not milk and honey in the Arabian Empire. Petty feuds had broken out among desert clans. And now, with the arrival of the Berbers, the decline was indeed quick. The Berbers moved in, settled down and gradually took over the city.

But a great civilization cannot be destroyed overnight, and when Maimonides was born, there still remained something of an echo of fineness from the voices of happier days. When he was thirteen, however, Cordova was captured by a Puritan sect of Moslems that had come out of Morocco. It was this sect that made the uncompromising proposal of "the Koran or the sword!"

Like our modern hill-billy fundamentalists, the captors looked upon learning as the seed of the devil. Science, books, and progress were all inventions tending to take the righteous away from religion. And so libraries were burned and mental pursuits completely discouraged. One could follow the faith or accept the alternatives of either leaving the country or suffering the penalty of death.

Maimonides was taken by his father on a trip that ended just outside of Cairo, Egypt. This may seem like a leap from the frying pan into the fire. In Fez, where Maimonides finally settled, non-believers were treated with open suspicion. Like so many of his race, Maimonides learned to compromise with surrounding circumstances, outwardly bowing to the conventions without protest, but secretly holding to his principles. He advised his racial brothers to do likewise, and at thirty wrote an exhortation on Jewry in which he urged acceptance of those inevitable difficulties besetting his race.

There were two incidents—seemingly little more than everyday events—that had a vital influence on his life.

The first was the death of his brother at sea. They had been in business together. Maimonides had begun life as a jewelry salesman. When his brother was drowned in a shipwreck, Maimonides

lost all interest in business matters and turned his attention to study. The second was the arrival in Egypt of that picturesque monarch, Saladin, about whom Scott wrote "The Talisman." It was the Sultan Saladin who united the Moslems in the East and spread their unity from Kurdistan to the Libyan Desert. It was Saladin, the warrior, who conquered Jerusalem and turned the Holy Land into the hands of the Moslems, a bondage from which it was liberated only during the recent great war when General Allenby recaptured and released it.

Though a warlike man, Saladin did not resort to the practices of mass massacre made so popular by the Christian Crusaders. He was fundamentally a kindly man, greatly interested in learning and given to magnanimous gestures.

Under his sway, Maimonides thrived—becoming Saladin's personal physician. In letters uncovered by researchers, Maimonides writes that he was practically swamped by his great medical practice. He tells of being so tired at the end of the day that he had to lie down while attending his patients and talking with them. His morning included a visit to the Sultan and calls on members of the harem and the royal retainers. The letters also revealed that he found time for but one light meal in twenty-four hours, and yet managed somehow to grind out an entire library of books on many subjects. Hard work, and indifference to food, do not seem to have bothered him greatly, since he was busily toiling up to the time of his death at the age of seventy.

In his late years he devoted a great deal of time to clarifying the cluttered scientific scene he had found all about him. Having read avidly the religious books of many people, he was intrigued particularly by the tales of miracles. He lived among people who placed utter faith in these legends of the miraculous. As a clear-minded thinker he had refused to accept them. He came boldly forward with the announcement that all things had a natural explanation. If, he held, there appeared to be no solution it was because man was ignorant of many things, and not because the things themselves were miracles.

With this thought in mind he sat down to write his "Guide to the Perplexed,"—an amazing document for the time when it was penned,—wherein he expressed the opinion that science, phi-

losophy and religion could be reconciled one to another. It was not until he was in his grave that the storm broke about this preachment. His books did not gain wide circulation until after his death, when they precipitated a scientific sensation equaled only by the announcement of the Darwinian theory.

In charting a life program for those who consulted him, Maimonides would refer them to Hippocrates.

"Know the laws of nature," he would say. "Know the laws of nature—that is the beginning. And when you have come to know them—follow them! Do this and you will be ill very little."

Therewith he would give them an elaborate lecture on temperance in all things.

"Avoid excesses," he would counsel them. "Take the middle course—the temperate course—not merely in eating, sleeping, drinking and loving, but in playing and in all other things."

He practiced what he preached, advising against giving a patient great amounts of medicine.

"Give nature a chance," he would say, requoting Hippocrates. "But help nature. Keep things about you in such shape that you will lessen the possibilities of attack. Try to prevent!"

Among his patients he was known as a "healer of both body and soul." While curing the body he would wisely minister to the mind as well. One of his most quoted precepts was: "For the preservation of health and long life, above all there should be moral purity, spiritual understanding, physical activity; whereas a loose life quickly leads to the grave. Learn self-control and seek philosophy for moral strength."

He passed on the Mosaic laws of cleanliness with personal interpretations, urging exercise, diet and activity. He took issue with the hermits of the dark ages, who lived in filth and squalor, contending that there was no kinship between saintliness and dirt.

His definition of an ideal city applies as well now as it did then. It calls for: good sewage, good schools, a library, a court of justice, water supply, places of worship, charitable institutions and bathing facilities.

He ended the list of the great Arabians. Thereafter intellectual and physical disaster fell upon the land. The last blow came with

the downfall of the Moors at the hands of Spain. Moorish libraries were burned by the Spaniards. The hand of the Church fell heavily. The general lethargy that affected the rest of the world lulled enterprise into a long sleep.

CHAPTER VII

Brewing Cauldrons and Brewing Storms

If you should care to trace your corner drug stores to their beginnings, you might start by paying a certain amount of consideration to an old cult of Chaldaic nature worshipers, who were convinced that every material thing was inhabited by a spirit. They believed not only that this spiritual essence could enter or leave at will, but also that it could be compelled to make its exit if it were properly invoked or exorcised.

These pioneers of the scientific unknown merely knew that when various liquids were heated, some vaporous thing escaped the pot and disappeared into the air. They knew that when they heated various metals and certain solids, peculiar changes took place which they could not explain. So they concluded that spirits were imprisoned, and were liberated by the application of heat.

To-day we pay these ancient folk the compliment of still referring to "spirits of ammonia"—"spirits of nitre"—spirits-of-this and spirits-of-that—spirits that will prevail in spite of all the legislation against them.

It is not historically safe to say that they were the first alchemists, or even that they were the first to attempt a solution of the mystery. We merely have more authentic records of their civilization. Metallurgists had appeared among them at an early date, and had spun all sorts of articles from the precious minerals.

They endowed metals with personality and identity. Base metals were like base men and noble metals, such as gold, achieved a high rating. We still refer to them as base metals and we still have a bromide about men with "hearts of gold."

Then they established a relationship between the planets and the metals. They knew but seven planets: Mars, Mercury, Jupiter, Saturn, Venus, the Sun and the Moon. They knew but seven metals: copper, lead, tin, iron, gold, silver, and quicksilver. They gave each

its heavenly complement and brought each under the influence of its particular planet. They felt that if they could but know and control the individual planetary influence they would eventually steal nature's secret. They took to studying the heavens and charting the skies. As centuries passed the ideas were filched and filtered many times, until finally a conclusion was reached in the late Middle Ages, that one essence or element was the basis of all others and that with the discovery of this element would come a panacea for all human ills, as well as a substance that would transmute base metals into gold. Thus, in a single stroke, would be solved all problems: man would have health, wealth, youth, and happiness. The secret was supposed to be contained in the "Philosophers' Stone," a vague name for an eternal dream that mankind has never surrendered.

There you have the tangled skeins of ideology out of which grew alchemy and the alchemical cults of the Middle Ages. To-day we strip away the mysticism and carry on the same search, using different names and symbols. We now look to the ion as the ultimate element or the basic force from which all things spring and assume their identity, and the Ionists are our most recent scientific cultists. There are many to-day who believe, and who bring the weight of experimental evidence to their convictions, that all matter is in the essential one primary substance, and that its variations in structure, shape, and quality are due to its inherent ions, or electrically charged particles, that are in a varying state of rapid vibration. The alchemist believed that so precious a metal as gold must once have been of baser nature. Even as the seed becomes the flower, and the egg becomes the chick, so must lead under the proper influences become gold. Gold was merely lead with a college education, but it must be sent through the right school.

And we must not pass them without doffing our hats to those weird alchemical brotherhoods. For out of alchemy came chemistry and with chemistry came the understanding of practically everything that pertained to human welfare: its nature, its action and reaction, and its application in relation to everything concerning human economy. Chemistry gave the death blow to empiricism. It gave us the nepenthe of anæsthesia, and the understanding of all drugs and pharmaceuticals, thousands in number, that are used to

cure our illnesses and ease our pains. Chemistry took the guess out of experiment. It fashioned the pattern after which the same thing happens again and again. Without it, warfare would go back to the phalanx, and the art of medicine to devil-worship. We only ask you to remember that every time you enter the corner drug store to have a prescription filled, you acknowledge an indebtedness to a regiment of puttering old meddlers. Without them, the Middle Ages would have been singularly unromantic. With them, is added a fantastic and eerie note to the general scheme of advancement.

The Middle Ages had brought the rule of Feudalism and of Church. Servility to command was the rule of the times. The growth of Christianity had completely upset scientific progress. Thought turned suddenly from all that was material into avenues of the transcendental. This was a quite natural reaction from the debauchery in which Rome had collapsed—a general searching for spiritual uplift. The new preachments told of the beauties of the soul and the necessity for its preservation. The body became a vile and vulgar thing, to be abased and hated. Men stripped themselves of their usual clothes and donned sackcloth. They put on the habit of monks and went into seclusion. They punished their bodies for the purification of their souls. They came to fear hellfire and looked toward heaven as the ultimate relief from worldly burdens.

When illness came upon them, they thought of the new Messiah who could heal by the mere laying on of hands. Men made pilgrimages to the Holy Land, and came back with strange relics—bits of wood from sacred trees and bits of bones from the bodies of saints and martyrs. These took the place of more ancient amulets and charms, and were used for healing and for warding off evil. New prayers replaced old, and new hymns took the place of old chants and incantations. "Healing shrines," such as still exist at Lourdes and at Beaupré in Montreal, made their first appearance—the most popular one of those early times being that of St. Ida. Papal suppression and general church authority stepped in to halt scientific progress wherever it appeared. Truly these were Dark Ages.

In one direction, however, there was decided improvement. The teachings of the Nazarene had made a definite difference in man's

attitude toward human weakness and suffering. The new Christian virtues included compassion. So we find hospitals and the practice of nursing enjoying a healthy popularity and growth. The sick found a steadily growing interest in their troubles, and greater attention to their needs. Pharmacy was not completely neglected. In fact the mortar and pestle inhabited the church before they found their way into the apothecary.

The admonition to "suffer the little children to come unto me" had not been without its effect. Endowments came from the wealthy for the maintenance of children's hospitals. Orphans and offspring of the poor found wards awaiting them. Pilgrims and outcasts found some one interested in their welfare. Charity had come into the world and cast its bright sunlight over suffering.

Up to this time, lepers were beings to avoid. They were outcasts from all society, groveling at church steps and in market-places, exposing their nauseating sores to the eyes of the world. Now came "lazar houses" for their keeping. As these spread, the necessity for their segregation became apparent and the first step in history was taken toward the stamping out of civilization's most dread disease. It is recorded that as early as 220 A.D. such leper hospitals had been instituted in what is now England. True, there was little or no effort toward treating them or finding a means for their cure, but steps were taken toward halting the spread of those accursed by its contagion.

As time went on, the ecclesiastical authorities let the hospitals slip from their hands into the charge of the municipalities and states, and gradually they became public institutions with human welfare as their aim.

In the sixth century, a plague which desolated the Roman world, despite prayers and supplications, gave a sharp twist to thoughts of physical well-being, at least in that one quarter. To this day, the instance of the great scourge is marked by a golden angel, atop the mausoleum of the Emperor Hadrian. The legend connected therewith tells of a religious procession that set out, headed by St. Gregory the Great. Thousands of paraders were chanting a litany for heavenly intercession, when suddenly Gregory had a vision of a golden angel standing with drawn sword at the peak of Hadrian's tomb. St. Gregory told of seeing the angel sheathe the sword. Co-

incidentally, the plague began to abate. This was accepted as a revelation of heavenly healing.

And, as the medieval period was closing, there came that other terrible scourge—the Black Death—grimmest and most devastating of epidemics. It appeared seven hundred years after the Roman plague, focusing in the Crimea and spreading over Turkey, Greece, and Italy, and then over the whole of Europe. Panic, despair and death followed its path. Eighty million persons felt its fangs. Individual survival was the urge of the moment. Families were riven. Motherhood itself was disloyal to its instinct. Children and nearest of kin were forgotten, and deserted in the furious pursuit of selfish personal survival. Great pits yawned for the dead. Streets were filled with putrefying bodies. Such terror as has never been known in all time gripped the world.

Out of it came, for the first time in history, quarantine laws. Venice, a seaport into which many fugitives sought entrance, was first to apply such a regulation. Notice went up that no strangers were wanted and that all persons aboard incoming ships would have to pass a rigid health examination. Other ports emulated her example.

Another scourge of the passing Middle Ages was syphilis, which appeared first as an epidemic in Naples. Its origin is obscure. Sailors returning from the New World after the expeditions of Columbus were accused of having imported it, but it was not known to the Indians. The nature of the disease remained a mystery for a long time, and many years passed before its venereal ætiology was suspected.

In the long unfertile interim, students who thirsted for learning began to gather in groups for study. Some ventured to exchange liberal and new ideas among themselves—and others found mentors under whose teaching they sought to fit themselves for more mature thinking. They turned to the translations that came in from the Arabs and they studied the Arabian writers, meeting through them the ideas of the old Greeks. Gradually they established the universities, the most important of which was located at Salernum, Italy, just a short distance from Naples. Next in importance was Montpellier. To the credit of the Popes and Emperors, let it be said that, with the passing of the Dark Ages, they began to show an

interest in the support of these universities and helped to foster their growth.

Let it also be admitted that many of those who left the world behind when they took the monkish cloth found themselves more interested in matters of physical life than they had anticipated. Particularly was this true of the Benedictine monks, who became known as the "Nestorians of the West" because they did more than a little toward preserving Greek thought and writing. The cloister of the Benedictines was at Monte Cassino, and here it was that Cassiodorus, as early as the sixth century, not only was calling the attention of the monks to the older writings, but was dedicating his brotherhood to the care of the sick and the poor, in accordance with the preachments of St. Benedict.

And behind the doors of court circles thought was kept alive, even as it was being discouraged outside its environs. When Charlemagne, in 800 A.D., rose as Emperor of the West the attitude toward the human body had a healthy stimulus. It so happened that bands of Irish and Anglo-Saxon monks had been wandering in the old Ionian neighborhoods and had there picked up the remaining strands of Greek teachings, scattering them about as they went. Charlemagne encouraged his court physicians, and while they did little toward advancement they at least kept matters at the "status quo."

In the twelfth century, the university at Salernum became the intellectual center of the Middle Ages. It maintained medical and surgical clinics and foundling retreats. It boasted women professors, as well as men, and sent out Sisters of Charity on nursing cases. Dissection of animals was practiced, and occasionally a human corpse found its way to the study rooms. From here came scores of writings that enjoyed wide influence during the time, the most famous of which is perhaps the "Regimen Sanitatis," a poem devoted to health subjects, filled with quotable material. It was in this book that the lines appeared:

> Slam the door on the doctor's nose
> With joy and temperance and repose . . ."

A little later, at the University of Bologna, students resorted to grave-robbing to get bodies for study, and four of them finally went

to trial on this charge. Bologna took great pride in its college and honored its professors with fine tombs when they died. The University of Montpellier sent out travelers now and then—such as Arnold of Villanova—who went into the Arabian lands and came back with great tales of what was being accomplished. It produced Henri de Mondiville and Guy de Chauliac, both excellent early-day surgeons.

But nothing new, of any consequence, happened. Patiently these mystical seekers of the Philosophers' Stone stewed over their kettles in darkened rooms. To present a more or less accurate picture of these fellows, we must turn to a paragraph culled from one of the writers of the times: "They follow diligently their labors, sweating whole days and nights by their furnaces. They do not spend their time abroad, but take delight in their laboratories. Their garments are of leather, with a pouch, and an apron, wherewith they wipe their hands. They put their fingers into the clay and filth, not into gold rings. They are sooty and black, like smiths and colliers. . . ."

Such was the incubation period of chemistry.

No one knows exactly how and when alchemy had its beginning. We do know that this dream of transmuting baser metals into gold still endures. Within the past few years at least two modern scientists have considered themselves on the right path and the chemical laboratories of a certain university have admitted in the press that hope was still springing eternal.

There is a general theory that alchemy was born in the very ancient mysticism of Egypt. The Greeks had given Egypt the name of Kemi, meaning "black lands," and the word "chemistry" can easily be traced to such a beginning—or to the Greek word "chemeia." Later the alchemists became associated with "black arts" and "black magic." They worked with materials of the Night, trying to fashion Daylight.

Also there is record that many centuries before Christ China had recorded tales of old fellows who stood over pots chanting their weird incantations. Almost every race seems to have been, at one time or another, affected by the desire to acquire the touch of Midas.

Occasionally a great fear spread that some one would actually

stumble upon the secret. The Emperor Diocletian, worried lest the Egyptians should spin gold from kettles and thus become the richest of peoples, sent spies abroad with huge sums to buy all available tracts and books upon the subject. These he summarily burned.

But the practice of alchemy as an art, and as an aid to health, is credited to those Arabians of the seventh century, concerning whose rise you have read in another chapter. Like many other important discoveries, chemistry was stumbled upon by accident. During those periods when curiosity was reaching a new peak and a creative fever had overtaken many men, the Arabs took to brewing mixtures of spices and condiments, flavoring extracts, and every conceivable substance obtainable. One day some venerable toiler substituted sugar for honey in the making of a syrup, and found that he had created alcohol. Another day, the aldehydes, nitrates, sulphates and other salts came into being. The julep, Kentucky's milk, was of Arabian origin.

Also in their searchings they learned the effectiveness of anæsthetics where pain is involved, and used hasheesh for producing a deep sleep. The "Arabian Nights" are filled with tales of sleep-producing agents, and one goes on to relate how a thief drugged a body of guards with hemp fumes, "the Princess Abrizah being put to sleep with a bit of concentrated bhang."

With this application of experimental brewings to human ills, there came the gradual organization of a new idea. Suppose, they asked, that this ultimate formula for gold is found. Would not this also be the elixir of life that mankind has been seeking since the beginning of time?

Therein lies the importance of their groping. They had begun to look toward two eternal goals—the release of mankind from drudgery through wealth, and the release of mankind from pain through a universal panacea.

Here was a task for dreamers to revel in. And, since most challengers find hidden champions, out of Mesopotamia and into the fast-growing centers of Arabian culture came one Abou-Moussah-Dishofar-Al-Soli, otherwise known as Geber. He dreamed of making gold and of creating a panacea for all human ills. Anything, it seemed to him, was possible. He had taken as his motto this

creed: "With prudence, patience and perseverance all things can be accomplished." So he set about being patient and persevering. Week upon week he would work over his pots and kettles, doing a bit of medical experimenting and practicing at the same time.

Finally he emerged from his dingy laboratories with a formula for the Philosophers' Stone:

"There exists," he announced, "a substance solid in form and round in contour, which is the Stone or the Grand Elixir. There is also a second stone of second degree, which is equal to the first in half the degree of perfection and which changes the commonest metals to silver. And the first will not only turn metals to gold—it will dissolve gold itself. It will be red for the nature of gold and white for the nature of silver."

With such an ambiguous and mystical notion, Geber then proceeded to take to his brewing. And, lo, instead of dreamdust, out of his soot-blackened workshop came chemical miracles. Out of the quest for a magical stone that would bring perpetual youth, dispel all ills and create riches, came silver nitrate and sulphates of copper and iron, aqua regia and the strong acids, purifications of salt, alum, vinegar, arsenic, soda, sal ammonia, saltpeter and potash. Mercury, sulphur and salt he believed to be the basic ingredients of all things and he wrote a book, the "Summa," in which he treated on the art of distillation and detailed the component parts of many solids and liquids.

Even as he dreamed and worked, still he trembled a bit at the thought of a successful conclusion.

"If I were to divulge this work," he wrote, "the world would be corrupted. Gold would then be made as easily as glass in the bazaars. . . ."

His work and announcements gave him a large following. Many eagerly dogged his footsteps. His teachings did not receive the general approval of Mahometan leaders, and many of his disciples paid for their loyalty with their lives. Geber, himself, once was put to flight and escaped death only through the intercession of a kindly caliph.

And there was one Rhazes, a young man who came out of Persia to settle in Bagdad. One day he stopped to talk with an old druggmonger. He was fascinated by the secret whisperings of alchemical

activities and decided to make a study of medicine and pharmacy. Up to this time he had been a musician.

When the wonders of his new endeavors became apparent to him, Rhazes joined the little army of mystical brewers, laboring long over his kettles. He practiced medicine by way of making a living and became an outstanding physician in Bagdad. He won himself a position akin to that of a city health officer when he made an investigation into the best way to prevent meat from rotting. He took pieces of meat into many parts of the city and hung them up, noting that the putrefaction was slower in a section that was cooler and not so generally exposed to the sun. This, no doubt, was the beginning of the idea of refrigeration.

In the course of his experimentation, a sort of madness seized him. He began to believe that he really could spin gold. Slowly he began to go blind, as the fumes from the pots affected his eyes. He died heartbroken and disillusioned, nearer to eternity than to his solution.

His contribution to health rests largely in his study of smallpox, and his application of dietary programs to disease. "When you heal by diet, use no other method," he admonished.

He was a firm believer in keeping his patient's mind calm and serene.

"Console your patients and give them cheering words, even when you know they are going to die," he advised in his writings.

Scores of anonymous persons were equally active and, by the thirteenth century, discoveries were coming by the dozen from the "sandalani," as those early-day drug stores were called. There came senna and camphor, musk and cubeb, cloves and sandalwood, ambergris, mercury, tamarind, and scores of other products of many lands and climes. All in all about 1,200 plants were differentiated. So important did this pharmaceutical activity become that the government found it necessary to undertake a rigid inspection of imports, and pure drug regulations were strictly enforced. For quacks —then as now—tried to take advantage of the situation by foisting fake herbs and concoctions upon the market.

Meanwhile, the alchemical vogue had taken a peculiar turn in Europe. Cults arose everywhere, dreaming new golden dreams. And as the hunt for gold and eternal health became more feverish

with the passing centuries, it developed Cabalistic groups, and created the great Rosicrucian order, branches of which exist over the world to-day.

There came a day when every king, every man of great wealth, every important man of title had his personal alchemist. And the fate of these mystic brewers was not always a happy one. Many a gibbet creaked with the corpse of one who had boasted too loudly and failed to make good.

As oil stock swindlers rise to-day, as golden promises of health, wealth and happiness have beguiled a gullible public through the ages, so the "alchemy rush" produced countless fakers and gave rise to the most elaborate frauds. Rogues appeared everywhere, equipped with consummate trickery. Some would hide golden nuggets between their fingers and produce them suddenly from a kettle, after going through all sorts of hocus-pocus. A company appeared in England, under kingly sanction, with authority to make gold, and they did produce a metal of golden hue which might have been accepted as real but for the canny Scotchman—they didn't clink right to him. Emperor Rudolph II caused little kiln houses to be built about his castle in Prague, each fully equipped for experimentation.

So completely "sold" on the idea did most of Europe become that specimens of "alchemical gold" were placed in museums, where they can be found to-day. It was incorporated into religions which saw "the Kingdom of God" as the achievement of "eternal bliss," and the "Philosophers' Stone" as the medium through which "temporal bliss" would be attained.

In all the welter of mysterious myth and legend no tale is more typical than that contained in a tract published in the sixteen hundreds by Helvetius, physician to the Prince of Orange. It tells of the coming of a mysterious stranger to the home of Helvetius; he left three packages "which contained a substance resembling glass, or very pale sulphur." The stranger whispered to Helvetius: "Here is enough of the tincture for twenty tons of gold." Helvetius bade his wife put the substance "on the lead."

"As soon as it was melted," he relates, "there came a hissing sound and a slight effervescence. After a quarter of an hour, I found the whole mass of lead had changed to gold."

Helvetius ran to the goldsmith, "who declared it the finest gold he had ever seen." The goldsmith was unable to keep this find a secret and spread the story about the city, and soon most of the population had gathered outside the physician's door. In vain they sought the "mysterious stranger" and in vain they sought to penetrate the mysteries of the "tincture."

This story is typical of hundreds of others in which figured "mysterious strangers" and "mysterious substances."

On the face of it, this particular phase of the alchemy craze may seem to have been dominated completely by greed, quite unlike the scientific ends sought by the Arabians. But here, avarice was breeding research. It was urging men to pry into nature's secrets. It was firing their imaginations and leading them toward tangible achievements.

Among the hundreds of charlatans who were amusing themselves with the chicaneries and foibles of a wistful illusion there appeared at least two men whose names have survived the centuries.

First there was Roger Bacon, who tapped sound roots of experimental science in spite of his leaning towards astrological and alchemical mysticism. Through all the haze about him, Bacon preached the necessity of original research and foresaw that nature must be studied by a newer and more thorough method. Friends saw his value to humanity and raised a purse equivalent to $10,000 for apparatus with which he might work.

It was Bacon who anticipated eye-glasses, telescopes, locomotives, and flying machines. It was Bacon who wrote: "Experimental science . . . verifies conclusions by direct experiment; it discovers truth which could not otherwise be reached; it investigates the problems and premises of nature and opens a knowledge of the past and of the future."

His difficulty lay in being born out of his time. With the rest of the world keyed, in any degree, to his particular viewpoint, he would doubtless have fired thousands of followers to action. As it was, his words were temporarily wasted upon thin air. He had uttered his challenge which was taken in the light of a daydream instead of a prophecy of man's eventual mastery of nature.

The second outstanding figure of the period came several centuries later—quite the maddest genius in all the catalogue. But

in the vigor and force lent him by his many eccentricities lay the essential power of Aureolus Theophrastus Bombastus von Hohenheim, known to us as Paracelsus.

Paracelsus came into being about the time that alchemy was on a high wave of popularity and astrology had moved in as a vogue in the diagnosis of various illnesses. Almost as late as the seventeen hundreds the faculty of a French university was seriously considering whether comets were or were not "harbingers of disease." The Almanac makers were beginning to chart the Zodiacal ailments. Pamphlets appeared and had a wide circulation under such titles as "The Way and Manner of Finding Out the Cause, Chance and End of a Disease by Astrological Judgment."

Our great-grandfathers, and some of our grandfathers to-day, have not been above taking with due seriousness the omens of the patent medicine almanacs that find their way into rural communities. Even to-day astrological parlors are plentifully supplied with patrons.

Under the satirical shafts of the great essayist, Swift, the hold of astrological diagnosticians began to weaken in intellectual circles during the eighteenth and nineteenth centuries.

But that was two hundred years after Paracelsus had come down from the Alps, a sturdy, broad-shouldered lad with a chip on his shoulder, and an aggressive, unflinching will of his own; a swaggering, bragging, loud-voiced, rough fellow, who took the wax out of the earth's ears.

In ecclesiastical spheres Martin Luther was preparing to stage his Protestant upheaval, and in artistic and cultural circles the Renaissance was coming to the rescue. It was a time ripe and ready for any mind in revolt. Paracelsus stepped into it as a lad of sixteen when he arrived at Basel, Switzerland, ready to take up his studies.

Paracelsus had had a good background. His father was a prosperous and well-educated physician in a little town near Zurich. The good doctor had given his son the benefits of a large library and considerable personal tutoring. Once in Basel, Paracelsus passed into the hands of the famous abbots and alchemists, one of whom—Trithemius—had quite a reputation for knowledge of the occult and was even considered an adept in the "black arts." Thus,

at an early age, he was being impressed with mystical teachings which, later in life, both "sired" and "damned" his views of life.

To this day, students of Paracelsus debate as to whether he was greater as a mystic or as a scientist—and the balance, so far as his general reputation is concerned, seems to weigh in favor of occultism. To the mystics he has remained a sort of high priest. To the scientists he represents a symbol of timely revolt, whose character is open to suspicion. A great deal of this suspicion, it is now admitted, was cast by enemies who voiced their disagreements in prejudiced and vitriolic writings.

Even as a young man, Paracelsus presented a personality almost certain to create hostility. He went about airing his views with eloquent cocksureness and browbeating and bullying his auditors into acquiescence. The same tenacity and aggressiveness that he presented to others he applied to himself. He became an indefatigable searcher for every sort of available information, and, annoyed by those who bowed to the accepted traditions, he tossed himself into the company of non-conformers.

He soon began to appear at the low taverns in company with barbers, gypsies, midwives, hangmen, bathkeepers, brawlers, and other colorful, though dissolute, companions of the barrooms and open road. He seemed to fit well into this motley brotherhood, being able to joke as obscenely as the next and to roar as loudly. And there was a great deal to be learned from this tavern crew, whatever their disreputable vocations.

The barbers were, for instance, allowed to practice surgery. Earlier in the Middle Ages, in fact, barbers, bathkeepers and wandering mountebanks made a general practice even of major surgery, and surgeons—to the time of Frederick the Great—were given little more standing than menials. Barbers, thanks to their cleverness with razors and scissors, continued this sideline, but gradually went in for minor operations, such as bloodlettings. Hernias and stones were maladies which compelled surgical intervention at times, and these operations were performed with deftness and skill.

Midwives were able to give Paracelsus endless tales of strange experiences encountered, and hangmen could reveal to him the reaction of men about to die. He collected a rare assortment of old-wives'-tales, impossible legends, and interesting facts.

PARACELSUS

But the duality of his interests drew him off and away. Having begun his penetration of the physical side of man, he suddenly developed a passion for studying the mysteries of the transcendental. His wanderings took him to many lands and he seems to have gone as far as India and into the land of the Great Khan, where, so he related upon his return, he was arrested and taken before the monarch, and was granted his liberty in return for taking the Khan's son on a trip of research and adventure.

He returned steeped in new mysticisms. He had come in contact with the "secret doctrines" of the East; the sort of knowledge that grew into theosophical and esoteric cults and inspired such works as the recent "Isis Unveiled." It was even claimed by some avid followers that, in Constantinople, he had been given the secret of the "Philosophers' Stone," thus having in his power the great supersecret, the key to the life-giving panacea and the open sesame to wealth. Modesty was never an impeding virtue with this young man, and he picked his press agents with rare discretion.

When he came stalking back into Basel, his manner and his attitude had scaled the heights of arrogance. He felt that he had eaten of wisdom to the point of surfeit, and that the knowledge of the universe lay in his palm. And what is more—he admitted it. With splendid showmanship, he swung an ornate sword from his hip, in the pommel of which was supposed to be prisoned a mysterious and vital spirit. It was one of those magic things to be picked up in the mysterious, far-away East.

He was now a personage to be conjured with and walked right into the chair of physic at the University of Basel. There are tales of how he came to his classroom too drunk to lecture and how he bickered and argued with his students. There are tales of his rough jests, of his near-brawls and his boastings. There are tales of how he openly challenged the older teachers, and with a final heretical stroke, threw from his classroom as archaic and impossible the writings of Galen and Avicenna. He ordered their books turned into a bonfire to the horror of the oldsters, and as the flames licked the pages, went about spouting that there "was more intelligence in his shoelaces than in a whole library of such stuff."

Therein lay his strength and his weakness. Out of such revolts against the established order came a most needed upset, but the

braggart manner in which he behaved brought him into ill-repute with his contemporaries. However, this may have been one of the best methods of driving his points home.

He did not last long in Basel. Enmities were engendered and grew into bitterness. He left secretly, wandering through German cities and shouting new reforms. Soon he was turning his invective upon the alchemists, decrying the fact that they labored for gain alone.

"Alchemy is not for the making of gold and silver," he would say, "it is for the making of the supreme sciences and to direct them against disease and for human welfare."

With evangelistic zeal, Paracelsus began to turn alchemical gropings into new directions. He applied himself to the laboratories, even as did the Arabians, with the idea of brewing substances that would aid mankind. And out of this eventually came organized and scientific chemistry. Surely Paracelsus had good reason to challenge the Arabian, Rhazes, for the title of "father of chemistry."

He made important personal discoveries: separated the various compounds of mercury, zinc, and differentiated them from preparations that contained iron. He insisted that the three basic substances were sulphur, mercury and salt.

While thus engaged he began to apply the occult and mystical to his work. There were forces beyond these visible and transmutable substances. There were certain "life forces."

What gave man vitality? he asked. What did a magnet attract? What was this power we know as personality and personal magnetism, that one man had and another lacked? What were all these hidden forces?

Paracelsus began to give definitions unheard of by European ears. He leaped into realms of transcendentalism and just as quickly returned to Nature. He insisted that one should follow where Nature pointed and apply research to its mysteries. "The wise man rules Nature, not Nature the wise man," he said. One could not become a physician, he argued, through reading old tomes and following old formulas; one must come into knowledge of the properties of things and one must benefit by personal experience. He began to explain his action in burning Avicenna's "Canon" as being not a rash and ruthless act, but as necessary because "what

is true and living, that the fire cannot burn." With such outbursts he began to stir thought for the first time in more than a thousand years.

But he was pursued always by the duality of his interests. He was ever trying to wed the problems of the spiritual and transcendental to those of the physical. To balance both his viewpoints, he held that there were persons who could heal through medicine and those who could heal through miracles. In the latter case, the physician had to be a man of God, the sick man must have the greatest faith in the power of the miracle. Both must be firm in their beliefs. Nor is this such a far cry from the views and practices of certain religious cults to-day, whose successes substantiate the practical value of this tenet.

In every physician there should exist the healer as well as the scientist. Too many doctors look at their patients with post-mortem eyes and regard them merely as examples of categorical disease. They make a diagnosis, and treat it, forgetting the fact that not only has the patient the disease, but the disease has the patient. Too often they neglect the personality behind the illness, and add fear and consternation to the one already afflicted instead of recognizing the universal fact that, barring infection and new growth, practically all diseases begin in disfunction and unbalance, and that in regulating the causative factors and correcting the errors that fostered them, lie the precious stewardships of the practice of medicine.

Returning to the potpourri of Paracelsian accomplishment, he furnished in addition to this collection of major and minor achievements the foundations of Mesmerism, many, many years before Mesmer was born, and flirted with the mysterious shadow of spiritism long before it was popularized. It happened in some such way as this: fundamentally Paracelsus was as much a Nature follower as Hippocrates. He believed in the unity of Nature—the macrocosm, or earth-world. The man-world, or microcosm, is the center of Nature and in this all forms of existence are contained. These were the natural or physically observable entities. In addition, there were strange phenomena: the attraction of opposite sexes; general laws of attraction as shown by the magnet in a physical sense and by personality in an incomprehensible sense—incompre-

hensible, at least, at the time. There were other mysteries, such as contagion and resistance. It was strange that when two persons were in the presence of disease, one would acquire it and one would not. It was strange also that, afflicted with the same disease, one would be quickly cured and the other die, although both had apparently been similarly constituted.

All such things, so far as Paracelsus was concerned, were beyond physical explanation, and answers were to be sought in the realms of the occult. What caused these occurrences? What was the healing force in Nature? What was the answer to the life principle, to the riddle of the invisible universe and the forces within matter?

Since words were invented to conceal thoughts, Paracelsus added not a few to the dictionary. When his ideas became too involved for simple expression, he merely stirred his lexicographical pot and out came "Archeus"—"Mumia"—"Yliaster"—"Entia," and so on.

In simple terms, all existence came from God. All material things from the Yliaster, or primordial substance. The Archeus was the force in Nature that put things into motion—the "Essence of life." This Archeus functioned through the influence of an invisible Mumia.

In diseased conditions, a malignant Mumia had entered the body —and it had to be magnetically extracted and inoculated into a plant bearing the signature of the disease. This plant in turn was under a specific influence from the stars. Diseases were caused by inharmonies of the firmament, acting upon the astral body of the man. On the other hand, he wrote quite logically about heredity, predisposition, and diathesis in relation to disease, and understood the nature of insufficient or retarded elimination as a causative factor. He considered five primal causes or "Entia": cosmic causes (ens astrorum); poisons (ens veneni), in which he included autointoxications and contagion; natural causes (ens naturale), under which he grouped predisposition to disease, and organic defects and malformations; psychic causes (ens spirituale); divine causes (ens deale). Somewhere between the refined and subtle mystic of Browning's poem, and the lying, tippling egomaniac of unfriendly tradition, we probably have the real Paracelsus, a gargantuan character in a gargantuan age. Yet his teachings and services were far-reaching, although frequently blindfolded in paradox.

Paracelsus began to wonder what influences brought about healing, what invisible forces were at work, and what invisible bodies functioned all about us. Why, he asked, does the flower burst from the bud? What is the unseen power that underlies it? And since an invisible perfume comes from the flower, what unseen essences spring from man?

Out of this latter question he developed the first concept of Mesmerism. For, said he, since these unseen forces spring from man, they can be passed from man to man. They can be impressed by one man upon another. Ideas, vital forces, and desires can be passed from one to another, even as diseases can be passed during contagion. One can go even further: by capturing and trapping some of these forces, they can be transferred into the earth and into plants. "Any one possessing this magnetic influence could cure diseases in others," he declared.

All this is but the undeveloped expression of Mesmerism! It remained undeveloped and unexplained for many a year. But out of it did grow two with "healing" as their mature movements. The first, and most important, has never entirely gone out of style. It was known as the "cure by sympathy" and was widely followed by many of the disciples of Paracelsus. It consisted of projecting a "sympathetic attraction" from the healer to the invalid and, in getting a sympathetic response, healing by "sympathetic magnetism." To this day physicians appreciate a sympathetic attitude toward their patients, but they do not apply it to the exclusion of all else. Nor did Paracelsus, for that matter. Several cults, founded on kindred theories, continue to flourish, particularly among the "misunderstood" and the generally neurotic.

The second turn taken smacked a bit more of the ancient rituals. It would be amusing did it not indicate the wistful and wishful gropings of undeveloped intelligences.

Briefly, the idea that brought about the "mumia vogue," one which, by the way, spread to many lands, was this: Since the body exuded some unseen and magnetic force, why not try to capture it? But how could it be trapped? Why not, they argued, by taking various things given off by the body and creating a magnet? So they mixed urine and hair and bits of warts and pus and excretions and such things as might appear on the surface of the human

body, and collected them in a so-called "mumia bag." These "mumia bags" served a double purpose, according to your particular faith. Some thought they should be placed over the area of pain and inflammation—much after the fashion of a poultice—and that they would draw out the pain even as a magnet would attract iron filings. Others thought that by casting off these excretions they could be passed on to others. "Mumia bags" would be tossed under doorsteps and left at the roadside for others to pick up, on the theory that the disease would pass from the original sufferer to the one who was unfortunate enough to become the eventual possessor. Since the latter savored a bit more of magic and witchery, it had the wider vogue, and there are tales of "mumia bags" scattered along many a well-traveled trail.

So far in advance of his time was Paracelsus that a volume could be consumed—and many have been—in detailing his discoveries, near-discoveries, theories and fantasies.

For instance, he skated over the Darwinian theory of the survival of the fittest. His particular observation, however, was that the "strong prey upon the weak." While working in the mines as a youth, studying metallurgy as an aid to his alchemy, he made the first observations on various diseases of miners.

After his own alchemical experiments he besought experimenters to turn to chemistry. He urged physicians to stop meddling with wounds and, anticipating the future antiseptics, advocated "the balsam of nature" as the perfect healer. He introduced the forgotten mineral water baths as a cure and analyzed them for the first time. He made laudanum. He located iron in certain waters, used alcoholic extracts in considerable quantities and left a dizzy trail of startling innovations.

Quite a task for one man, you must admit—particularly considering his esoteric involvements and the fact that his dissolute life led him to a miserable death in his early fifties. His death is credited to a brawl with one of his more drunken tavern companions.

Regarding him in the mirror of his times, the world must take off its hat to his infinite courage. Volumes have been written on his bad manners and habits, his dissoluteness and vulgarities, but Time gives a profound respect for what were then considered heresies.

Paracelsus actually faced death a hundred times from a hundred quarters that his ideas might be born. This was not an age to condone or tolerate heresies. Many a man had been put to death merely for asserting far less revolutionary ideas. Driving full tilt against prevalent superstitions, his was a reckless and defiant attitude. Right or wrong, he must be given a place high among the freethinkers, iconoclasts and deliverers.

In regard to those things for which he is most frequently attacked, permit him to speak from the grave through his own writings: "He who would study the Book of Nature must wander with his feet over the leaves. Happy is he who wanders, possessing nothing that requires his care. . . . I have not been ashamed to learn from barbers and vagabonds. I was in search of my art, after incurring the dangers of life. . . . A lover will go a long way to meet the woman of his choice. How much more will the lover of wisdom do when searching for his divine mistress? . . . You will not find the teacher of Nature in a corner poring over books. We must hunt down knowledge."

Let this, then, be his epitaph!

Unfortunately for science, his mystical teachings enjoyed a more immediate following than his sounder precepts. In spite of him most dabblers preferred alchemy to chemistry; doubtless it was simpler and required little, if any, intelligence. His transcendental ideas were elaborated upon, until they finally grew into the famous Rosicrucian order, a fantastic brotherhood embracing pseudo-scientific precepts. It required about a century for this group to develop. It had as antecedents and contemporaries the Cabalists, Hermetics and Zoroastrians, from whom it garnered the most plausible tenets.

Briefly tracing its rise: there appeared early in the seventeenth century three mystical books called variously, "Confessio Fraternatis," "Fama Fraternitatis," and "Chymical Marriage." It was advertised that the supposed author had gone widely through the milk of Oriental cults, gleaning the very cream of mystical thoughts. With this very secret information known to but half a dozen Westerners (he had several companions), the hard-earned blessings of earth and heaven would be communicated to those who would join the "Brethren of the Rosy Cross." They casually let

it out that they had the secret of the Philosophers' Stone in their hip pockets (probably pre-war) and could make gold if and when they wished to. This, of course, they disdained to do since it materialized a heaven-sent secret. Perhaps, however, their greatest immediate appeal lay in their oath to minister to the sick and the poor.

The name Rosicrucian is presumed to have come from one Rosenkreutz, who for a time was credited with the authorship of the mystic books. Credit is now given a certain Johann Andreas, a pastor of Württemberg. Branches of this order still exist, and to the original long list of mysteries have been added, in the course of the centuries, a number of chapters on dietetics.

Turning back, however, to those years immediately after the death of Paracelsus, we find the forces of the Renaissance directing thought toward a long neglected channel—the structure of the human body itself. And to this all-absorbing phase in development we now turn.

CHAPTER VIII

The Skeleton Comes Out of the Closet

ART may have begun for Art's sake. But the records of cave walls leave us mystified as to whether the primitive artists were displaying an impulse for self-expression, or whether they were trying to atone for the death of fearsome beasts by reproducing their likenesses. With the Greeks came the first translation of the human body into forms of pure beauty. By stressing physical perfection, they provided the world with early lessons in surface anatomy. But they left man still quite ignorant of his skeletal and internal structure.

With the Renaissance came a more careful consideration of fundamentals. As every art student knows, the basis of his training is a thorough study of anatomy. It was something like half a century before Columbus planted first the cross and then cross-breeding on American soil that this relationship was fully grasped and applied. From the necessary application of anatomy to art grew a better understanding of the human structure. Reproducing—drawing—painting—removed the taboo from the nude. The individual who, more than any other, deserves credit for this emancipation, is that genius, born out of wedlock to a noble father and a peasant girl . . . Leonardo da Vinci. The world well knows the paintings of da Vinci, but it is largely ignorant of the scientific zeal which caused him to study the human body and to learn its structure bit by bit. His was a veritable passion for the penetration of nature's secrets. Nearly a thousand sketches and drawings in chalk left to posterity testify to the accuracy with which he made his post-mortem observations. He charted the complicated articulations of human bones and followed the wandering trails of muscles and veins. He found himself fascinated by the functionings of the lungs and the heart, the bony structure, the nervous and circulatory system and even the brain, making truly remarkable studies that were leagues ahead of

any contemporary. These were lost for almost two centuries, and it was about 1700 that they were discovered by William Hunter, an Englishman, before his work was properly appreciated. Summarizing, briefly, his contributions to human knowledge: da Vinci originated cross-section anatomy; he delineated the position of the fetus; he sketched the bones of the skull, the spine, the feet and the hands; he drew cross-sections of the brain and tried to map the blood vessels and muscles.

With da Vinci the wheels of a modern day began to revolve. Thereafter, even though they slowed down, they did not stop. Almost a century passed. In the universities were groups of students, stimulated by the same ardor of youth as college boys of to-day, and just as ready for adventure, fight, frolic or serious purpose. Even as the present-day campus lads, they frequently combined all these assorted ingredients of college spirit. Their leader was a young man of unflinching courage and seemingly inexhaustible energy. His name was Andreas Vesalius. The name had been taken from the little town of Wesel, in Belgium, where he was born. His family name was Witing, and his father had been apothecary to the king, Charles V. When very young he revealed a precocity for observation, a power which he developed to almost microscopic acuity. His keen eyes were matched only by his amazing memory for things he had seen; his enthusiasm was untiring; his interest unflagging. Such tenacity of purpose has been common to most great scientists, whether they have toiled through the night hours over test-tubes, telescopes or trigonometry.

There is a tale that Vesalius, when a mere infant, was taken by his parents to a bathing resort. That he might be supported in the water, they supplied him with bladders, something like the modern water-wings. The story goes that he gave immediate attention to the buoyancy and elasticity of this contrivance, made from a hollow organ of a contented cow. While this sounds like the imaginative exaggeration of proud mothers and fathers, biographers have accepted it and passed it on. Certain it is that all through his youth an intense interest in the structure and workings of the body possessed him. While he was generally assiduous, his teachers would find him stealing time from his prescribed studies to pore over the medical works of the monk, Albertus Magnus, or of Michael

ANDREAS VESALIUS

Sootus. But he became impatient with their lack of conviction and tossed them finally into the corner.

"What do these fellows know about it?" he would ask. "They have never really examined the body. If you want to find something out, you have to look for yourself." This, of course, is the basis of modern medical training. Lacking these opportunities for intimate study, Vesalius created them. At first he had nothing to work on but the mice and rats he trapped and took to his room at night. Cats and dogs in his neighborhood had little chance of enjoying long life. His family and his teachers, greatly interested in his efforts, arranged to send Vesalius to the University of Louvain, and he was so apt a pupil that in 1533, at the age of 20, he was on his way to a larger institution in Paris. There his first teacher was Jacobus Sylvius, who seems to have been a testy and irascible old tutor, who at first took a great interest in his brilliant pupil. Sylvius had a great reputation as a martinet, and a greater one for self-importance. A tenacious believer in old Galenic teachings, Sylvius eventually turned acrimoniously on his progressive pupil, deriding Vesalius at every opportunity and turning his fellows against him.

Going back to Louvain when the French wars broke out, Vesalius struck up a friendship with a young fellow named Reiner who, like himself, was a student zestful to get beyond the limits of ordinary tutoring. One evening they were taking a walk, exchanging confidences and talking about their youthful scientific ventures when, accidentally, they found themselves in the Tyburn, which was the execution ground for criminals just outside the city walls. Hanging was the ordinary method of execution, and it was a custom to leave bodies exposed for several days as an object lesson to any who might pass that way, especially to townsfolk who might be bent on straying from the narrow path.

It so happened that this pair of scientific Huck Finns or Tom Sawyers came upon a most unusual and grisly scene. A few days before a notorious robber had been put to death and the law had determined to make his case of great moral value.

"Hanging," the neighborhood had said, "was too good for him."

So they had neglected this usual ceremony, preferring to chain him to a high stake and roast him alive. A slow fire had been

built beneath the victim's feet, and he had been left to furnish a feast for carrion birds. To an ordinary Huck Finn and Tom Sawyer this would have been a scene too frightful to face, and they would have turned and fled. But the young Vesalius, wrapt in his interest for learning, found a strange laboratory specimen made to order. He stood spellbound and trembling with excitement at this amazing discovery. Fate, he felt, had certainly been kind to him. Even the vultures had helped him, for they had cleaned away the carcass and left as well preserved a skeleton as ever he had looked upon.

Vesalius looked about to make sure no one was watching. Then, using his companion's shoulder as a ladder, he tore away such bones as could easily be dislocated and hid them under his coat. Stealthily they left.

That night Vesalius lay tossing in his bed, scheming well into the night. Midnight came . . . with a half-moon to light his way! On tiptoe he left the house and went back to his eerie task, as other boys might go in search of buried treasure. For, to him, this was unburied treasure! This was a find too good to be true; a chance to get a real honest-to-goodness skeleton all to himself.

Vesalius realized his danger. He had no idea what might happen to him if he were discovered. He took no more chances than were necessary. He went back to the ghoulish task night after night. Each time he had to pass through the city gates. Each time he had to shinny up the stake and wrestle with the iron fetters that held his precious skeleton. Each night he would wrest a few bones free and bury them, like a dog. When his task was accomplished he would carry a bone at a time to his room. Bit by bit he reassembled the skeleton. He worked over it craftily until he had each bone in proper place. Meanwhile, the authorities had missed the body. And when, some time later, it was noised about the town that the young student was displaying a completely assembled skeleton, an investigation was started. After all, his deed had been too bold to escape detection. When inquiries were made, Vesalius insisted that he had brought the bones back with him from Paris, but he wasn't believed and was banished from the city by the authorities.

Since he had achieved his purpose, this didn't bother him much; it brought him considerable publicity. Also it brought him a great

deal of experience. He had found out enough to whet his appetite for more. He had actually rearticulated human bones and had found how a human chassis was constructed.

Wherewith a year later he entered the service of the king as a surgeon in the army. Battlefields, said he, were fine places to get bodies wholesale, and no one would interfere. So off went Vesalius to the French wars, avid to have new opportunities for first-hand study. He seems to have been a good student for, his service at an end, we find him in Italy attracting almost sensational attention by giving public demonstrations of his knowledge and destroying old misinformations and half-truths. He was still in his twenties, and his youthful figure, lecturing in the streets of Venice, came to the notice even of learned educators. They came out to hear what this young newcomer from Flanders had to say.

To their astonishment, they found him demonstrating even as the veriest street faker, even as the modern medicine man might display his wares of fake salves and unguents. He stood dramatically before a suspended skeleton, the very sight of which frightened the children and shocked the timid. Blindfolded, he was defying the gathered crowd to touch any individual bone which he could not name and describe. Now and then the challenge was taken up, and with wizardly speed and accuracy he gave his replies. In this way he hoped to convince them, for he had determined to prove his case by whatever method might be expedient. With a showman's sound psychology, he used the good old blindfold stunt—perhaps for the first time in history. And his astonishing knowledge struck awe and wonder into the minds of all who watched him. Distinguished graybeards found him a veritable miracle-man, since he seemed to have more knowledge of the human frame than any one who had ever lived upon this planet. They shook their heads and marveled that one so young could be so learned, and went back to the universities carrying tales of this wonder-youth of the market-place.

It was not long, therefore, before an invitation to the Paduan University came his way and Vesalius was on his way to become the first professor of scientific anatomy, with a nice salary. He remained in Padua for several years. His fame spread rapidly. Two other universities sought him and he consented to teach. His

advancing reputation led him to a professorship at Bologna, where he first met Cosmo, Duke of Florence, and a man of great wealth and influence. The Duke backed Vesalius both with money and with power, obtaining for the young scientist a seat at Pisa, with a salary of 600 crowns for giving a short course of demonstrations. The Duke also commanded that the authorities furnish the young tutor with a fresh supply of corpses whenever he should wish them for classroom purposes.

This was indeed an innovation, and an amazing stride in advance of the custom. So new was the idea of dissection that the very announcement of such an event became nothing short of a public holiday. Fêtes and parades were arranged and stages for a dissection, as for a modern circus. Soon anatomical theaters were built at Padua, Montpellier and Basel, and bands blared up the streets in advance of a performance. Crowds attended. In the more Catholic sections Papal indulgences for dissections were issued and the cadaver, which had long been a symbol of filthy flesh, as against eternal spirit, suddenly took on a certain dignity and importance. A Papal seal was issued and cadavers were properly stamped for the dissection theaters. In England, the disposal of bodies was still marked by utmost strictness. They were doled out by edict. Surgeons and barbers (they were still practicing there) were allowed four bodies of executed criminals each year and Queen Elizabeth, with great generosity, decreed that Cambridge University might have two bodies a year. Certain interested students began to get private skeletal collections and, it is believed, the first medical museums had their start from this practice.

Such regulations, however, did not stop those who desired bodies from getting them. Professional grave robbing, particularly where criminals were buried, and petty graft in prisons became quite common. One could arrange to have one of these little jobs attended to by one of the vagabond student group, who appeared in great numbers about this time. They were a dreaming, poetic, colorful crew, living literally from hand to mouth. They begged, stole and lived by their spades, tasting poverty more often than food and constituting as ragamuffin an army as ever poured into classrooms. Some of them were extremely precocious and a credit to their schools. Some became minstrels and poets when business was bad,

singing from door to door. A great many became tavern characters, joining a vast army of quacks that went about the countryside practicing fakeries and keeping themselves well filled with beer. In Paris, Montfaucon, the execution yard made famous by François Villon, was a favorite resort for body snatchers. It had been used more than once by the young Vesalius.

In such an atmosphere, Vesalius was fortunate in having a friend whose patronage gave him such wide liberty. When he went back to Venice the power of the Duke Cosmo went with him and he was able to solicit bodies of condemned criminals from the jail-keepers and to make suggestions to magistrates concerning the mode of death penalty to be inflicted. There was nothing sentimental about Vesalius' attitude. In cold blood he suggested the type of death for various poor devils that he might obtain new physiological information from the post-mortem investigations. Frequently, when a number of interesting cases were facing him, he would suggest to the court that certain executions be delayed, since he was well supplied with subjects and would prefer fresh material when he had more leisure. Such was the power of Duke Cosmo, that he was able to get pretty much what he wanted. Few men in scientific history have had better opportunities handed them on a marble slab. It was too good to go on forever. Eventually the Duke died and Vesalius' power was shorn.

Thereafter Vesalius took to keeping tab on men dying from various fatal maladies. When they died he watched where they were buried, and made night visits to churchyards to examine their bodies. Often he had an avid young student rob the grave and bring the body to his study. Many a corpse was brought to his room, and often hidden in his bed. It is said that Vesalius actually slept with many a dead man. For, perhaps, never has there been an individual whose zeal for knowledge so completely took possession of him that it rendered him impersonal to all but his aims.

There is no more amusing tale in his strange career than one growing out of an experience with an anonymous corpse. Vesalius had been teaching classes in Padua and Bologna when, one day, he desired a female corpse for study of feminine organs. He sent out his students to bring one in. After scrimmaging about they had learned of a certain Laura, whose body had been for sale in

life even as in death—and without question. Looking up her record the students discovered that she had left no word regarding the disposal of her body and, as a young woman of easy virtue, she had the social rating of a "free-willed" person. Since she had cared so little for her body in life, the students felt that no large outcry would go up if it were discovered that her grave had been tampered with. Whereupon, under cover of night, they set about disinterring the body and brought it to the dissecting rooms.

Now, it so happened that a certain monk had not been as attentive to the welfare of his soul as he might have been. He had met the lovely Laura while she plied her trade and had forgotten his soul now and then, in permitting the pleasure-pursuit of his body. When she died the monk sought release from his recent grief in the excitement of an anatomical dissection, just as one might go to the theater to-day. He was sitting in the little semicircular bank awaiting coming events, when in came the students with the corpse of his late beloved one. Starting from his seat he cried aloud and his hysterical behavior revealed his secret to the assembled students. An irreverent group, they greatly enjoyed his discomfiture. And not the least merry was the young Vesalius, who made no pretensions of his dislike of monks in general, declaring them to be pretenders and obstructionists.

When Vesalius was twenty-five he decided to put down what he had learned from his various broad experiences in a volume, "The Fabric of the Human Body"—one of the greatest works of all time. An accuracy and exactness never before approached was now to be found, and with his anatomical data—which lives uncontradicted to this day—he supplied information on surgery and physiology in general. The illustrations were the work of John de Caloar, a pupil of the great Titian. The invention of printing during the "Revival of Learning" made this book of particular importance to future generations, who had merely to turn to its pages to get their data.

In his work, Vesalius not only took issue with Galen, who was considered up to this time to have been the supreme anatomist, but treated the Galenical findings with scorn. This was, of course, nothing short of inviting a wildcat to dinner. Doubtless Vesalius was aware that he was challenging all his brothers to war, but

he could not have foreseen how bitter their enmity would be. His old teacher, Sylvius, was one of the first to take up the cudgel of antagonism. The feeling against him spread. Groups gathered to discuss what should be done with him, and students whispered about it in the street. A conspiracy of silence was then started. Vesalius found himself alone, a man apart from the world, ignored, unbefriended and unhonored.

Sadly he would go through the streets, meeting students he had loved and guided. It had been such a short, short time ago that he had parted from them, sad at the parting, yet happy in the thought that he was setting out to conquer new worlds. How proud he had been of his book! He had not entrusted any ordinary printer with this work—it had come from the press a beautiful thing: —paper carefully chosen, cuts perfectly made, type of the finest making—one of the great books of the world. And here he was, a pariah!

Now there was nothing of the martyr in the make-up of Vesalius. He was, and always had been, a fighter. He could find no comfort in martyrdom. He could not go about living in the grand belief of being misunderstood and above the herd. His feelings whipped into a fury. He took the scornful letters of his old teachers and tore them to bits. In his study were great sheets of notes, books and manuscripts. In disgust at the world, he kindled a great fire and threw them all in to burn to light-winged cinders. Then he stalked out and vanished from the country.

There are many tales, most of them conflicting, of what happened to him in the next few years. But, eventually, he appeared at the court of King Charles V as personal physician to his majesty. He was now about thirty years of age, and in spite of all the shoutings against him, he made his place as a distinguished surgeon and an active practitioner. But prevalent wars took him off with his king on campaigns or, in the interim, kept him in court circles. His day as a great experimenter and teacher in the universities was over. He had bitterly left all that behind. He had acquired a wife and family, and let life go drifting along. But he was heard from now and then in outbursts against the prevalent orthodoxy. He never picked up the challenging hat he had once thrown into the ring. Once, when a particularly loud cry went up, he issued

a public notice announcing that upon the following day he would demonstrate at a dissection, "If," he cried to his challengers, "I am wrong, come and show me my errors! If," he defied them, "you are right, I invite you to make your dissections openly from my subject and prove me wrong!" But no one ventured to accept his challenge!

In the end, he grew tired even of protesting, though he was still very young. Charles V died and he became the physician to Philip II. He became the typical court physician; well-fed, well-clothed and part of the social life.

It is recorded that "in those long, tedious years in Madrid he could not get hold of so much as a dried skull, let alone the chance to make a dissection." What wormwood for this young man! He saw his own students rise to haunt him. There was one Matteo Colombo, known as Columbus, who had been one of his dearest pupils, but who turned derision and discredit upon him. With the old teacher, Sylvius, he became one of Vesalius' most bitter opponents. And there was his very favorite pupil, Fallopius, to whose credit it must be said that he did not hurl invectives, and showed at least the loyalty of silence. With the decline of Vesalius, Fallopius immediately became his successor and for some time was credited with the glory belonging to his teacher. It was the world's fault rather than his own. For Fallopius made definite contributions. He discovered and named the ovaries, and fallopian tubes. He described the female genitalia, the placenta and cleared several of the intricate problems of the anatomy of the brain.

Meanwhile, Vesalius was drifting to a tragic and early end. While, in so far as the outer world was concerned, Vesalius showed little interest, his own inner fires had kept burning. He still longed for opportunities to study and learn.

They tell the story of a young Spanish nobleman whom he had been attending and who was one day reported dead. It had been a curious ailment and Vesalius was greatly interested. He asked his royal chiefs for permission to hold a post-mortem examination. They consented and he repeated his request to the young nobleman's family. They also consented. The usual throng of interested ones gathered about the dissection table. As Vesalius opened the body, to his horror and the terror of all about him, there appeared

slight signs of still existing life. While they watched with fear-frozen eyes they definitely saw the heart expand and contract. They turned upon the astounded Vesalius. Accusation and suspicion were written upon every face. So this fellow didn't know when to quit!

"Vivisection of a human being!" they cried. And poor Vesalius, his young life already wrecked, could only shake his head and mutter denials. But the mob was at his heels. And his enemies were only too glad of the chance for revenge.

"To the Inquisition," they demanded. And so he went—another of the martyrs of science, to be charged with murder. Fortunately for him, the king was friendly. Vesalius had been far too good and loyal a doctor to be deserted at such a time. The death penalty was revoked, but he was exiled. His life was spared on condition that he make a pilgrimage to the Holy Land.

There is, however, another story declaring all this to be pure fiction, and that Vesalius grew bored with court life and took the pilgrimage by way of escape. He was on his way home when a messenger came to him with the tidings that he might return to Italy and his old chair at Padua. Happily he began to speed his voyage. But his ship was wrecked on the Island of Zante. There he perished miserably; hungry, ill, heartbroken. A traveling goldsmith found the body and buried him among strangers. The goldsmith, at the time, had no idea whom he had interred. There were no avid young students there to dig up the body.

Vesalius had fulfilled his mission! In the face of a world that clung with superstitious tenacity to the idea that the body would be resurrected, and hence that it should remain intact in preparation for eternal bliss, he had managed to break down barriers that made possible late scientific experimentation and medical progress. After 1,500 years of a Christian era and millions of years of life upon earth, man could now for the first time look upon the framework of his body and understand it. The great gap had been bridged! A new day had dawned! The most vigorous and unconquerable spirit in the entire story of health had won his battle over great obstacles! As usual, his immediate times did not catch up with him. Within his very day Servetus, as Miguel Serveto was called, went to his death at the stake, burned alive—another martyr to

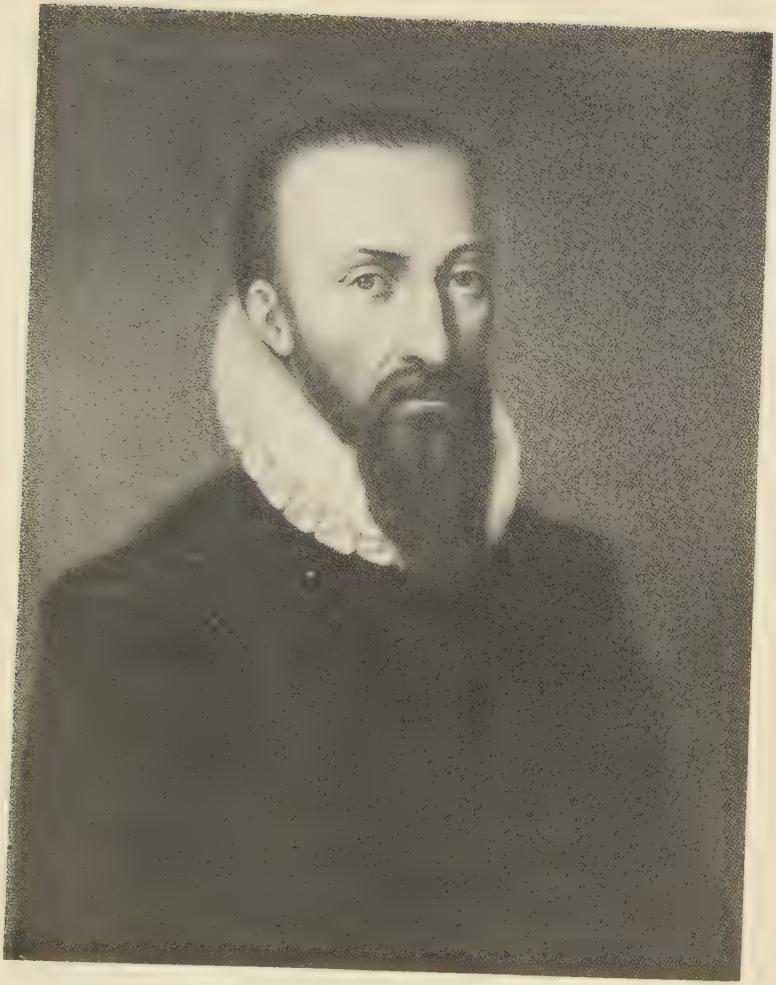
science and human welfare. Anticipating Harvey, he had discovered that the blood, in pulmonary circulation, passes into the heart after having mixed with air in the lungs. But he made the mistake of mixing himself in religious discussion. Theological quibbling brought an end to his career.

Generally speaking, however, a great spirit of restlessness and revolt had begun to enter the world. An eager spirit of inquiry, a thirst for new knowledge, a tearing down of old dogmas was to be found in individuals and in general attitudes. Also there were needed reforms instituted. France and England had begun to legislate against the crude, barber surgeons. England, in particular, tightened up its regulations. Early in the eighteenth century, it was decreed that no one should practice either medicine or surgery in London, or for seven miles around, without an examination by a board of four experts acting under the Bishop of London. Outside the seven-mile limit a similar body functioned under the Bishop of the Diocese. This eventually grew into the Royal College of Physicians.

It is interesting, in passing, to record that the red and white barber poles, so familiar to all of our main streets, had their beginning about this time, thanks to the United Barber Surgeons, which organized a guild to protect their interests. As insignia of their organization a skeleton was shown supported on such a pole, which was decorated with their red and white colors:—red for blood and white for bandages.

In this same period, the handling of war-time injuries and wounds showed amazing improvement, and military medicine advanced almost to modern efficiency. Field hospitals, equipped with rather efficient ambulances, had been introduced by Queen Isabella of Spain. One of the most important figures in this particular branch was Ambroise Paré, who won the reputation of the greatest military surgeon of all time. This same Paré followed Vesalius in seeking to give science the opportunity of examining bodies after death, and it was due to his efforts that France finally gave judicial permission for post-mortems which soon became the common custom.

There is one other whose name should be listed—Pierre Brissot —who pioneered new methods of bloodletting, reforming the old, outworn systems. While a professor of the Paris faculty, he took



A. PARÉ

his stand, and paid for it by being branded a heretic, and banished.

So ends a vital period! With one great riddle solved, science now turned to another:—How did the interior apparatus of the human being really function? Once more—pioneers were awaiting the call!

CHAPTER IX

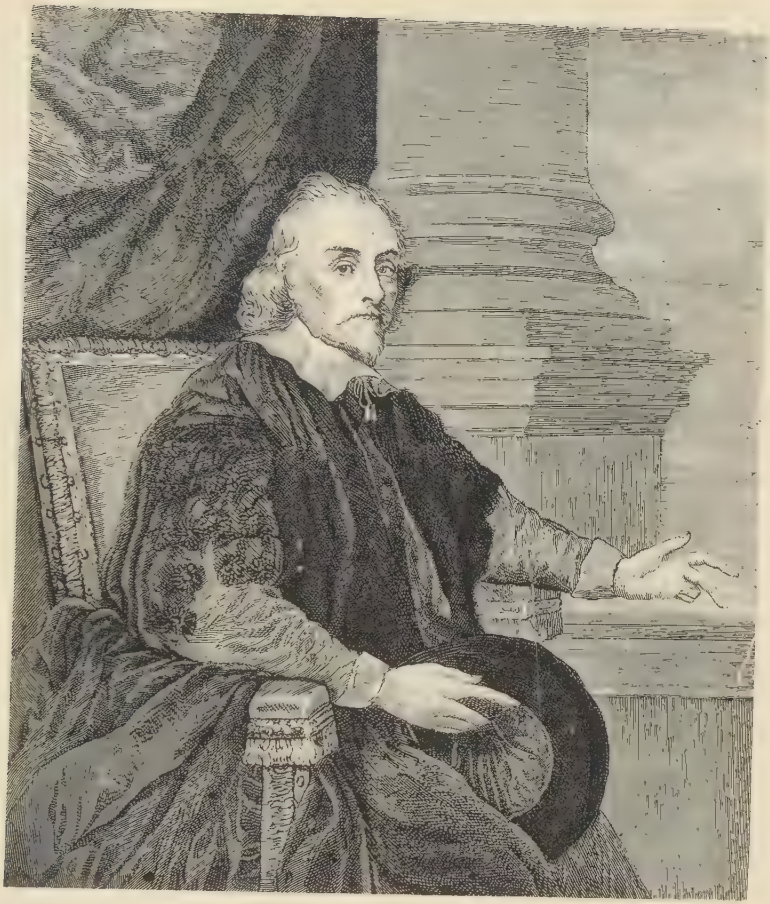
Heart Interest and Circulation

In the same Paduan University that offered Vesalius his youthful opportunities, there stood one day—about sixty years later—another young genius. His name was William Harvey. He had just come from England, drawn by the reputation built about the Italian school by its proud list of achievements. Harvey was short of stature, with a sort of pallidness of complexion that accentuated the raven blackness of his hair and the snapping darkness of his black eyes. He displayed a tendency toward nervous impatience through such little mannerisms as fingering at his dagger handle as he stood, or running his fingers through his hair. He was a restless type, and when conversation was animated, he could hardly keep his seat, so interested was he in all that might challenge his mind.

His physical appearance was generally unimpressive, but his eyes reflected an inner light. They were sparkling eyes that flashed curiosity and intelligence; they were quick and penetrant eyes, almost wistful at times, and dreamy, but always kind. His forehead was broad and domed in a manner that, in later years, suggested a striking resemblance to Shakespeare.

Harvey was born into a century pregnant with achievement. All the arts, having been reincarnated from vanished spirits of antiquity by the belated Renaissance, had survived a tempestuous adolescence and were now striding full tilt into the hallowed halls of immortality.

Germany, alone, was being torn asunder by the "Thirty Years' War." But in England, Holland, France, Italy and Spain—except for desultory displays of militarism—the pen and brush challenged the power of the sword and the merchant ship threatened the glamour of the Armada. New lands were being colonized. New ideas challenged old concepts. Montaigne had resurrected the classics to a



WILLIAM HARVEY

modern interpretation and significance. Bacon, in his "Novum Organum," had put human thought on stilts. Shakespeare had cast his imperishable breath upon the mirror of eternity. Cervantes had sung a comic requiem to the institution of Feudalism, which the invention of gunpowder had destroyed. Spinoza in philosophy; Rembrandt and Velasquez in painting; Racine and Corneille in drama; Milton in poetry and Cromwell in politics—these, and many others quite illustrious, had put tradition into the discard, and had contributed a newer, broader impetus to the advancement of civilization.

Side by side with these geniuses of a genial century stood William Harvey, a true pioneer in Science,—Science, the youngest and sternest daughter of Slow Time. He was born in 1578, son of a prosperous Kentish father. His early education was the best the times afforded. At Canterbury, and then at Cambridge, he evinced an interest in medicine, and upon completing his studies he visited France and Germany, finally selecting Italy for his post-graduate work.

On the particular day that Harvey's career begins to interest us, he was in the classroom observing his teacher, Fabricius, who was the medical Nestor of his day, demonstrating the valves in the human veins. It was Fabricius' favorite lesson and was under way in an anatomical theater that the teacher had had built for himself, and which, by the way, still survives. In the center oval, or arena, was the dissecting table, and all about stood students in circular, banked tiers that rose from the floor. Just under the arena was a preparation room, with a trapdoor as a means of communication. Through this the dissecting table was raised and lowered as the specimens were selected for the classes.

As a senior student, Harvey was allowed to assist the professor at these demonstrations. Ordinarily, there was no more attentive and fascinated observer. But on this day, though his dark eyes were fastened on the network of veins revealed upon the instructor's table, his thoughts were far away. A number of new and startling ideas were running through his mind—thoughts that he did not as yet dare frame into questions. These ideas had been slowly formulating. They had been born of observing, time after time, the series of tiny, cuplike valves that appeared in the veins. Clos-

ing his eyes, he could imagine these little cups snatching the precious blood drops and sending them on one after another.

Fabricius taught that the blood flowed from the heart through the veins and that the cups prevented it from flowing too rapidly. This idea of Galen's had dominated medical thought for twelve centuries. From time immemorial it had been known that the heart beat and the blood flowed. Did not primitive sacrifices prove this? When the blood stopped flowing, the heart stopped beating and the animal was dead. Man was at times conscious of his heartbeat and at other times oblivious of it. Any strong emotion made him aware of the fact that there was an organ in his chest that throbbed a tattoo in time with the music of his emotions. Heart throbs, answering the impulses of love and fear, peril and anguish, convinced Aristotle that the heart was an organ of mystical significance. To him it was the seat of the soul, the abode of life and the source of the spirit. The poet cannot speak of love, his favorite theme, without heart interest. We still speak of young women who "wear their hearts on their sleeves" and of young men with theirs "in their boots."

It is almost impossible to think how the comparatively simple problem of the mechanics of circulation had escaped the acumen and erudition of the Greeks and the painstaking patience of the Egyptians. Not to their discredit, let it be said, that they suffered serious handicaps. Religious restrictions excluded the possibility of using human material for autopsy, and vivisection was out of the question, since they did not know how to keep animals alive long enough to make accurate observations. The Greeks believed that the arteries contained air, because they were empty after death.

Galen overthrew the Greek theory founded by Erasistratus. He taught that the liver separated subtle vapors or "natural spirits" from the blood which it manufactured; that like a great sponge, it squeezed blood toward the heart through the veins, where it was mixed with air to form "vital spirits." The lungs were a bellows to keep the temperature of the blood from getting too warm. From the heart, the blood was carried to the brain and elaborated into "animal spirits," and, as such, diffused by the nerves. He had noticed that the blood on the right side of the heart was different in color from the blood on the left side. He was under the im-

pression that it passed from one chamber of the heart to the other through invisible pores in the septum between the left and right cavities, or ventricles. He thought that the process was akin to perspiration, where fluid was seen to exude through the skin without any opening being apparent.

Vesalius had denied the Galenic pores, but he had no conception of systemic or pulmonary circulation. The heart to him was a reservoir from which the blood ebbed and flowed. His descriptions of the anatomy of the heart were almost perfect, but he never knew what made the works go.

Strong indeed were the convictions of the Middle Ages. It was almost 1,500 years after Christ that the courage of Columbus prevailed over the repeated attempts at mutiny on part of his crew, and proved that the earth was round. It was about the same time that Servetus, a pupil of Vesalius, asserted a difference of opinion from the Galenic conception of circulation by stating that he agreed with Vesalius that the blood did not ooze from the right to the left chamber of the heart, but, furthermore, that it was driven through the lungs and there purified, and returned to the left heart by way of a large vein. So heretical an opinion, true as it was, merited contemporary suspicion regarding such a man's entire method of thinking. Servetus, as previously stated, was the recipient of a classical reward for his labors. He did not survive the "Trial by Fire."

It was a precarious thing for any one to assert himself in opposition to accepted scientific tenets. Harvey waited until he returned to England. The problem of circulation had not been settled to his satisfaction and he had determined to solve its enigma. Harvey was accepted as the best anatomist at Cambridge University and stepped from there into the College of Physicians where, after nine years, he began to give lectures. Now in these lectures there appeared a strange and new expression. The tight, cramped handwriting of the scientist, preserved in the British Museum, revealed the revolutionary statement that the "blood circulates." "Circulates"—that was the word that made the difference! It implied a circular motion, a rounding of a course. Yet, for some reason that time has failed to explain, this word brought no immediate response; it seems actually to have gone unnoticed, to have caused

no stir and raised no question. This, despite the fact that Harvey gave his lecture many times. It was not until something like a dozen years later, when Harvey published "De Motu Cordis et Sanguinis," a little seventy-five-page pamphlet, that the significance of the word broke with full force.

It may be that Harvey, himself, was timid about shouting too loudly or attracting too much immediate attention. Perhaps he was well satisfied at being left alone. Or perhaps he was too engrossed to care or to give heed. But, as Harvey himself admitted, he had barely been able to believe his own eyes. Watching the heartbeats of animals he had vivisected, Harvey reached the conclusion that he had come upon things beyond the powers of man to fathom and, perhaps, beyond human understanding. Astounded by the amazing mechanism and perfect regularity of the heart, he jotted down: "I was tempted to think that the motion of the heart was something that could be comprehended only by God."

For, you must remember, he had no instruments of precision to aid him, no modern invention to call to hand, and very little of established fact upon which to draw. He was dependent solely upon his sense of sight, and, such was the rapidity of the heart's action, that he could not at first perceive when the contractions, or systoles, took place and when the relaxations, or disastoles, occurred. When, many years later, Count Montgomery was wounded in battle and his breast was torn away exposing his heart, Harvey was able to determine the coincidence of systole—or the beat at the apex of the heart—with the impulse in the artery.

The most spellbinding trick of the magician is exceedingly simple when it is once explained. Every schoolboy to-day can easily understand the circulation of the blood. It was Harvey, however, who first revealed the mystery, and he came upon his knowledge by observations so apparently simple, that it is astounding that it took so long a time to be disclosed. Harvey noticed that each time the heart beat against the breast, the pulse could be felt externally. He had taken a throbbing heart in his hands and watched it grow firmer and harder each time that the blood flowed from it. Here he was, like the poet Keats looking into Homer for the first time. A new and brilliant truth flashed into his understanding. The heart expelled the blood from its ventricles by contracting its mus-

cle fibers! Every previous point of view was in error. The very wisest minds had reasoned that the blood flowed into the ventricles from the liver. The contrary was the case. The blood left the ventricles and entered the heart only when it was relaxed. The heart was a pump which sent the blood surging through the system in perpetual motion and with perfect rhythm as long as life remained. The arteries, indeed, did not contain air. They contained blood! It was sent through them by the heart, bringing nourishment and vitality to all the organs of the body.

How did the blood get back to the heart? Harvey noticed that, when he cut an artery, every heartbeat produced a spurt of blood. This could not go on forever unless the supply of blood was continually being replenished. Surely the veins were the channels that brought it back. The little valves which he had first seen in Italy were so placed that they assisted the blood in flowing toward the heart by preventing its return back into the tissues. Harvey put a tight bandage about his arm. The veins distended below the bandage, not above it. This was the proof of the fact that the blood passed to the heart through the veins, and not away from it, for otherwise the engorgement of the veins would have appeared on the side of the bandage nearest the heart. Furthermore, Harvey corroborated his conclusions by his observations at slaughterhouses. He noticed that after an animal had been slaughtered, it lost practically all of its blood within fifteen minutes, and that this blood made up about one-twentieth of the animal's weight. That would make it about seven and one-half pounds for the average human being. The heart chamber held about two ounces. If the blood did not return to the heart, how could it be pumped out in less than half an hour? The blood, therefore, went round in a circle—in other words, it circulated.

Harvey then observed the valves of the heart and the blood vessels entering and emerging. He soon proved that the blood entered the heart through the right auricle, or upper chamber, through the great systemic veins; that it was then propelled to the lower right chamber, or ventricle. From here it was pumped into the lungs for purification. From the lungs it was returned to the heart into its upper left chamber, or auricle; then into the left

ventricle, from which, invigorated by the inspired air, it was pumped from head to foot with undiscriminating precision.

This, in short, is the story of the circulation of the blood. Its transcending importance in the quest for health cannot be sufficiently emphasized. The cornerstone of the science of human physiology had been laid. Human metabolism, that is, the building up and tearing down of our bodies, our intake and our output, could now begin to be approached in the light of study with some degree of coherent understanding. All that the blood means as the great feeder of life; as the host of defense against bacteria and toxins of infection and affliction, with which Nature has surrounded us, making life precarious; as the purveyor of drugs and remedial agents to assuage our ills and cure our ailments; as the carrier of those subtle internal secretions that not only influence our constitutions, but preside over our temperaments and personalities—all would have been lost to us without Harvey's epoch-making discovery.

The full meaning of Harvey's announcement created a furor. Harvey himself seemed awed, if not a bit frightened, at the paths into which his experiments were leading him, and he jotted down a strange confession of his fears:

"I not only feared injuries to myself from envy, but I trembled lest mankind at large become my enemy, so much does established custom become second nature. Doctrine, once sown, strikes deeply at the root, and respect for antiquity influences all men. Still I have cast the die, and my trust is in the love of truth and the candor of cultivated lives."

In this last line are words that deserve to be hymned wherever progress and human achievement are mentioned. They may sing and build legends about the heroism of warriors, yet here we find an avid young scientist defiantly and fearlessly facing palpable danger at the hands of his fellows, yet pronouncing the ultimatum: "The die is cast! My trust is in the love of truth!"

There was as much method as madness in Harvey's apprehensions. Controversies arose on all sides. Skeptics demanded to know how the blood got from the arteries to the veins. This question Harvey could not answer, and it is a pity that he died without being able to prove that it did. Science tolerates no surmises. The capillaries, or terminal blood vessels, were so minute that they

could not be seen with the naked eye. It remained for the microscope and an Italian physician named Malpighi finally to prove Harvey's conceptions.

In the mesentery, the tissue that binds the intestines to the abdominal wall and which in the frog is a fine, transparent membrane, Malpighi first saw under the microscope the infinitely delicate communications between the arteries and the veins of the capillary circulation. Even under a powerful glass, however, the discovery had almost escaped him. He had first seen the contrary motion of the blood in the veins and arteries, but for some time was unable to trace any connection between the two. Finally his microscope penetrated a section of the frog's lung and excited and overjoyed he cried out: "I have looked upon what no other eye has ever seen!" Then it was that he first saw the network of fine vessels, intercommunicating, and establishing the validity of Harvey's theory.

The practical importance of this discovery was immediately realized. What had always been considered the romantic vision of a dreamer was now the stepping-stone for all future physiological experimentation. In 1660 a Dr. Lower, of London, let the blood of one animal flow into the veins of another, and the great life-saving operation of transfusion was performed. To-day transfusion is one of the miracles of surgical endeavor, but in these times of scientific progress we know that only certain bloods are miscible with others. Many tests are undertaken to prove that the cells and serum of one patient will not conflict with the cells and serum of another. The blood of a donor must be congenial to the blood of a recipient, or else tragic consequences occur. In 1667 Denis, a French physician who followed Lower's animal experiments upon the human being without the benefit of previous analysis, must have obtained disastrous results, for in the same year the French Parliament passed an act forbidding transfusion in human beings and dubbed it a criminal practice. In all well-equipped hospitals of the present time the doctors who are interested in diseases of the blood have on hand a list of names of donors, that is, people who sell their blood in cases of emergency. The type of blood of each donor is specified and catalogued, and at a few hours' notice he can obtain the proper blood for any patient whom acci-

dent, operation or disease has exsanguinated, and inject the vital fluid fearlessly and safely. The donors, who give anywhere from a pint to a quart of blood for an insignificant amount of blood money (say $50 or $100) are not at all exhausted by their donation and usually walk away from the operating room, smiling and jocular. It has on occasion proved quite an affront to the pride of a man whose vanity traces his ancestry back to aristocratic progenitors to find that his blood was identical with that of a Mexican peon who had never known his mother and whose father's name might have been "Legion."

The knowledge that we possess of the heart and the blood vessels and the blood, inadequate as it may seem to the meticulous specialists in this field of medical science, fills thousands of volumes that have been contributed by ardent researchers ever since the days of Harvey. The heart is the great pump that maintains life. Its incapacity begets incapacity of the entire human being. Its condition with regard to its health and disease determines the life span more than any other organ of the body. Its size, its shape, its functional capacity, the condition of its muscles, its valves, its energies, are problems that control us every day in the most poignant manner. "A man is as old as his arteries" is an old dictum, and the arteries are many. They are the pipes which represent the heart in extension. They are pulsating elastic vessels that leave the heart in the great aorta and ramify to every last functioning cell, bringing the nutrient blood to it. The elasticity of the arteries keeps up a continuous flow of blood, and as we grow older the arteries harden and the nutrition of tissues is impaired. Innumerable illnesses are visited upon the human body and the ills that flesh is heir to become clinical entities.

A few specific experiments concerning the heart and the circulation may be of interest. The heart is the only muscle that beats independently of cerebral nerve supply. All other muscles depend for their action upon their nerve supply. The heart of a cold-blooded animal, like a frog or a turtle, will beat for hours after it has been excised. The mammalian heart has been kept beating for hours, and even days, when immersed in a solution which is chemically similar to the blood serum. Dr. Carrel, of

the Rockefeller Institute, has kept a piece of heart tissue in the embryo chick alive for almost twenty years.

Consider the work that the heart has to do. It keeps up its perpetual rhythm and pumps the heavy blood continuously through the innumerable blood vessels with a pressure capable of sending it eight or nine feet upright through a narrow tube. It maintains this through the normal life span of threescore years and ten, through all the strain that is put upon it by physical effort, emotional insults, and disease. Truly it is a remarkable mechanism.

The determination of this blood pressure was first attempted by Stephen Hales, an Englishman, in 1733. He used a glass tube and a horse. Inserting the glass tube into an artery, he noted the height to which the column of blood was pumped. It was, naturally, impossible to carry out this method in a human being. Many devices were contrived. It was not, however, until 1847, that Ludwig in Germany made practical a crude model which, after many improvements, evolved into the convenient little instrument which finds its place on every doctor's desk and is the most important weapon of the life insurance examiner. The pressure of the blood is measured by a column of mercury in a narrow glass tube so calibrated that its readings for a normal man or woman correspond in round numbers to one hundred, plus the patient's age. The blood pressure indicates the resistance of the arteries to the beat of the heart and the flow of the blood. When the resistance is high, it means that the heart is being put to too much work and the life span impaired; when too low, it usually means that our dynamic energy is insufficient to carry on a proper circulation.

It may be difficult to conceive how the blood gets back to the heart, having passed through these very tiny capillaries where the rate of flow is slow and where the pressure is almost nil. By injecting certain easily recognizable dyes in the jugular vein of one side of the body and waiting for its appearance in the jugular vein of the opposite side, it has been determined that the time of one complete cycle of circulation is less than thirty seconds. The return of the blood to the heart, through the veins, is dependent upon many factors, the most important of which is muscle tone and exercise. It has been found that a rabbit suspended motionless for half an hour dies of anæmia of the brain. This was the

cause of death in crucifixion. The drugged bodies of the victims, immobilized upon the cross, were unable to pump the blood to the brain and a cerebral anæmia produced death by insufficiently feeding the centers of respiration and circulation. This is practically seen every day in the fainting spell, where the blood, leaving the brain, accumulates in the veins of the abdomen, resulting in suspended animation. We treat these patients by lowering the head and pressing upon the belly. Consciousness is soon restored. Possibly the reason why the human being is the only animal that does not walk for the first year of his life is that the muscles are too feeble to undertake a return circulation to the heart in an upright position.

As before mentioned, the modern contribution to the study of heart and circulation, with the assistance of the X-ray and electrocardiogram, the chemistry of the blood and its structure, as revealed by the microscope, would in itself fill many volumes and is too intricate for those not scientifically educated. Perhaps the earliest and most interesting contributions were revealed through the discovery of the microscope. The invisible had become visible. Nature's long-shrouded secrets were now bared to the inquisitive eye of man.

There has long been a dispute regarding the invention of this instrument which plunged sudden light upon a clouded world. Both the Dutch and the Italians have claimed its discovery. Many efforts at settling the argument have failed. There seems to be no way accurately to trace the microscope before the year 1660, though there are records of individuals who either made or owned one. These may have been imperfect instruments, or slight variations on the telescope or magnifying glass. Leonardo da Vinci found his eyes straining at the fine lines with which he sought to perfect his drawings of the human body and turned to experiment with lenses to help him out. He perfected some sort of magnifying glass which was used not only by himself, but by fellow artists similarly engaged. Then we find a Jesuit priest named Kircher taking bits of blood from plague victims and telling of a strange "brood of worms" he had seen with the aid of powerful lenses. But easily a leader of the microscopists, and a pioneer, was that persevering and patient Dutchman, Anton van Leeuwenhoek.

Leeuwenhoek was scarcely a man one would expect to go marching spectacularly down through time. An obscure man, even a commonplace man, he came of a family of comfortable and honest burghers whose livelihood was derived from fermenting hops and malt into a palatable beverage. He had no education to speak of and little background. Sent to school after the death of his father, he had preferred an apprenticeship in a store. Learning this trade, he set up in the dry-goods business in Delft, married, and settled down to the same complacent and colorless comfort that had marked the lives of his forefathers. His political ambitions were gratified by working at times as janitor in the Delft city hall. Business was not always so brisk as to occupy his entire attention and, by way of a hobby while sitting around, the young Dutch merchant took to grinding lenses. He ground them this way and he ground them that. It amused and pleased him to see the various changes that came over objects when they were observed under glasses of varied sizes, shapes and contours. And as he went on grinding, he became more and more engrossed in his lenses and less and less interested in his business. He was particularly pleased with the bits of glass that made tiny objects grow larger and larger to the eye. It was a fine and absorbing pastime. And, since he was looked upon as a stolid Dutch shopkeeper, he was left pretty much to himself. No one would have accused him of intelligence, since the cognoscenti spoke in Latin—a language which was Greek to him.

Once fascinated by his hobby, he went around to professional lens grinders and watched their methods. He went also to the apothecary shops and the alchemists' laboratories, learning to work in metals so that he would have a frame for the bits of glass he had been grinding. His chief virtue at this time seems to have been a fascinated interest, an untiring disposition and a sense of pride that made him want to grind the best possible glasses. So out of the molten metal and the pieces of glass, he began to fashion crude microscopes. And when he had made them he went about putting anything and everything under the glass to see what would happen. He would put bits of meat or bits of cloth, bits of hair and leaves from trees, lazy flies that he caught in his store and insects that crawled over the counter. And he was amazed at what his glasses

revealed! The thing took possession of him. He began to turn out one microscope after another, making slight changes so that each object examined presented different aspects. Before he was through he had made 250 microscopes and had ground innumerable lenses.

Because the good folk looked on him as a recluse, and a bit of an eccentric, the tradesman did not do much talking about his instruments. Yet people knew about them, and one day there came to his store Regnier de Graaf, who held a membership in the Royal Society of England. And when Leeuwenhoek saw that this man was truly interested, he brought out some of the instruments and allowed the other to enjoy the wonders of the tiny worlds under the glass. De Graaf wrote an enthusiastic letter to the English society, and upon a later day the tradesman found a letter urging him to tell what he was seeing through the wonder glass. His reply brought a hurried and eager request for more reports on his findings.

While considering the invitation, the storekeeper—assisted by his young daughter, who was his constant aide—caught some rainwater from the eaves and put a few drops under the glass. Looking through, his astonished, squinting eye beheld a moving mass of tiny creatures and he called upon his daughter to verify what his reason almost doubted. Leeuwenhoek had discovered microbes—those little plants that ever menace man's health, and which have taken a greater toll of human life than all the wars and persecutions of history.

Thereafter he caught more rainwater as it dropped directly from the sky into a freshly cleansed pan and again examined the drops. Now he could detect not a single creature. Pure rainwater was clean and clear! In all other water he always found the drops full of spinning, squirming little specks. Bacterial and protozoan contamination had reached human eyes about 200 years before it became manifest to human understanding. He began to mix odd little particles of matter with his pure rain drops. One day he took a tiny speck of pepper and saw the wigglers multiply by millions. He wrote at once to the Royal Society and, though they doubted the storekeeper's word, they brewed pepper water and had a lens specialist rush them a high-powered glass. With verification came

new wonder and Leeuwenhoek found himself elected to a fellowship.

Then, even as with the man in the woods and his mousetrap, the world came to the Dutchman's door. Royalty from many lands, and scientists and the ever curious. They urged him to sell his microscopes, which they said were the world's best. But he was jealous of his handiwork. He would not part with a single one. He did, however, plunge more avidly than ever into experiments. There seemed to be no end to the places where one could come upon exciting discoveries. Even the bits of food that gathered between the teeth, he found, were filled with tiny creatures. Yet, one day after he had been drinking hot coffee, he found the food morsels no longer contained these motile organisms. From this, he concluded that heat killed them. On another occasion, using the tail of a fish, he located the minute capillaries through which the blood goes from the veins to the arteries, and thus might have anticipated the later scientific work of Malpighi. He put bits of his blood under the glass and watched the globules. He studied shellfish from a near-by canal. There was little near about, in fact, that escaped him.

The years slipped by, so fast that he hardly knew he was an old man—a very old man. At ninety-one he lay on his deathbed, and only in death did he agree to relinquish his precious glasses. Selecting his best lenses, he made a dying request that they be sent to the Royal Society that had so respected and honored him. Thus passed into new hands the finest microscopes of the time. And into the splendid charge of a more scientific mind—Malpighi's—fell the task of finally establishing the complete circulatory cycle.

Man now was at least passingly familiar with the operation of his heart and his blood stream. Yet countless individuals were afflicted with maladies of the heart and nothing had appeared in the vast category of drugs that seemed of any particular benefit. So we are brought to the strange story of foxglove, or what we are pleased to call to-day digitalis.

In Shropshire, England, there lived a cronelike old woman. She would go about the countryside gathering herbs and brewing them and drinking them and giving a certain brew to the countryfolk who suffered from dropsy. She gained the reputation of being some-

what of a witch, with a capacity for magic potions. Bit by bit her reputation spread, until tales of the crone reached the ears of a certain Dr. William Withering, of Birmingham, where he was physician to the general hospital. At first he gave little credence to the stories he heard, but it so happened that an Oxford dean, who had been ill from dropsy, found that none of his medical friends could aid him. One day an old servant came to him and in pleading tones urged him to try the mixture brewed by the old Shropshire witch. Made a bit desperate by his condition, he was ready to try anything once, and so consented. He found himself greatly improved. Withering heard of this case and decided to look into the matter.

A few days later he appeared at the old woman's hut and urged her to tell him what she had put into the brew. Since she was fast growing both rich and important, thanks to the demands of the countryside, she was loath to reveal her secret. Finally, however, Withering learned from her that the secret of her potion lay in a certain mixture of roots. He noted each one and concluded, at length, that it must be from the foxglove that the benefits were derived. He began experiments, using variously the leaves and roots and deciding that the best results were obtained from the leaves. Trying it in varying quantities upon patients—many of whom may have had interesting reactions—he finally determined a dosage and advised patients to stop using it when certain untoward symptoms appeared. He had no scientific knowledge of its action.

And so was discovered in a flowering plant that grew in great profusion, beautifying the English landscape and garden, a drug that has been one of the greatest boons to mankind. The innocent foxglove and the decorative poppy have each contributed a pharmaceutical product which, rightly used, not only adds years to our earthly existence, but in malady and agony comes as God-sent relief to our tortured bodies. Foxglove, which has given us digitalis, has its specific action upon the heart, nourishing its muscles, slowing its beat and making its contraction more energetic when disease and overaction have exhausted it. Nothing in the whole domain of clinical medicine is more startlingly miraculous than to see a patient with the blue lips and ears of a failing circulation, gasping for breath on the very borderland of departure—and presenting

all the symptoms of a failing heart—quickly restored to convalescence by the benign and blessed digitalis.

In recent years much has been contributed to the chemistry and pharmacology of the drug, so that its dosage and physiological activity have been standardized. Dr. Mackenzie in London, Dr. Cushny in Baltimore and Dr. Eggleston in New York, have been largely responsible, together with several German scientists, in giving us preparations of this drug that have taken much of the fear out of cardiac disease.

CHAPTER X

Science Lays Its Egg

When the highway of health becomes rough and rocky, the average man of to-day takes a detour that leads him to a small sign:

Dr. Blank

Office Hours

9—11 A. M. 5—6 P. M.

He waits nervously, fingering the thumb-worn pages of an antiquated magazine, or engages another fellow sufferer in conversation, and discusses symptoms. Eventually the impatient patient is ushered into the office of the doctor, where he tells his tale of woe; and after an examination, superficial or exhaustive, his condition is labeled, and he is treated. The practice of medicine was ever a precious stewardship, the child of a marriage, so to speak, between the Science of Diagnosis and the Art of Healing. And Dr. Blank is proud of his calling and avid in his desire to give his patient the best advice that knowledge and experience are able to provide.

In the seventeenth century when a man went to a doctor he was at the mercy of an exponent of some current viewpoint, born out of a chaos of conflicting ideas. He was submitted to any system of treatment that happened to be enjoying temporary vogue. He, too, walked into the doctor's sanctum—"a Man"—and hobbled out —"a Label." But the "Label" was considered without any reference to the "Man." Nor was the "Label" a definite name signifying a definite malady, commonly understood, and similarly interpreted by the guardians of health, but it was an uncertain entity, shuttlecocked between Fad and Fancy, until its aspiration

to identity resembled the well-known "hash." Diseases were not classified, and the catalogue of symptoms was largely a jumble of unrelated ill-humors.

Another phase: our modern drug store is a place in which the compounding of an occasional prescription may interrupt the dispensing of sodas and postage stamps, but, nevertheless, it is a clean and sightly emporium, licensed under diplomas, and subject to laws that should serve to protect the unprotected public. But in Shakespeare's day it was a "needy shop" in which "a tortoise hung—an alligator stuffed, and other skins of ill-shaped fishes." To-day—medicine is disguised in pleasantly prepared pills, pellets, capsules, lotions, liquids, unguents and so on, easy to look upon and not unpleasant to take. Even castor oil, the baneful consequence of childhood's indiscretions, has been rendered palatable. But glance at the London pharmacopœia at the time when John Milton may have sought redress from his approaching blindness, and you will see that the apothecary might easily have handed the poet: bee's glue, cuttlefish, fur, feathers, hair, human perspiration, spider-web, snake-skin, swallow's nest, sea-shells—and other concoctions, which our sense of delicacy compels us to omit, but upon which our own Mark Twain commented with narrowing nostrils, that "when our ancestors swallowed a sigh," their discomfort was relieved by "following it with a sewer."

To comprehend the confusion and conflict that bred discord and even acrimony among the Æsculapiads of this century, it is essential to remember that progress in the pursuit of health was like a march out of the night into a day of newer aspect and broader scope. Galen's path, comfortably trodden for centuries, was turned back upon itself, and its sign-posts obliterated. Even as monarchs were being dethroned, so was the hierarchy of the Plausible put upon the stand and cross-examined until it tottered before the fire-trial of Truth. The errors were many and world-old; the corrections difficult and beset with snares; and we to-day are more than ever in the throes of hoping for the unblemished metal.

New discoveries had been made and there were newer discoveries to come. The tang of it was in the air. Out of the ancient and quiet seas of habit and tradition, there arose a radical Sea-god, blowing new complexities with every breath. The ship of science

was being buffeted by angry waters, but it was heading for an eventful land of practicability and progress. Man, having sipped of new Truth, was intent upon draining the cup, and seeking, as never before, to find the laws that governed natural phenomena. The structure of Faith had been challenged, and now the very citadel of Reason was attacked by the heresy of independent minds.

The first skirmishes were insufficiently supported, the premises fragile, and the conclusions unsound. But the spirit of modern Missouri was rampant through Europe, and Church, State and Home, willing or unwilling, yielded to the clarion call of "Show me." Ever in the van was the zealous pursuit of health, for no matter how human principles change and adapt themselves to temporal compulsions—human instincts have remained as they were.

Let us recall that Harvey flashed like a comet through the dark skies of established ignorance and left an illumined trail to inspire the entire intellectual world. Harvey had reduced the great problem of the circulation of the blood to mechanical principles. The human heart, long since considered the fountain-head of all emotion, was merely a muscular pump that beat for a time even when removed from the body. The blood with which the ancients had besmeared their sacrificial altars was merely a fluid coursing through the body on some vague mission. Why not consider the entire body as nothing but a machine in which things happened as they did in any mechanical contrivance, depending only upon force and resistance?

Following Harvey, the Italian, Borelli, seconded the mechanical motion and founded a new school of thought in medicine. He had been a Neapolitan mathematician (a pupil of Galileo, for that matter) when his interest turned to the human body. His reasoning, quite naturally, had a mathematical twist and he began to see functions in terms of purely mechanical processes. According to the preachments of his school, the movements of the muscles, the construction of the skeleton, the action of the joints, the intake of food and its elimination, the regular beating of the heart, and the synchronous breathing of the lungs were all significant of one interpretation. Like all natural phenomena that came within the domain of physics and mathematics, these manifestations of life must follow dynamic laws and be subject to dynamic influences.

As usual, sheep came tumbling after the bellwether, offering, however, many novelties of conception. No matter what your ailment, you were weighed and measured, added and subtracted, bent and flexed.

The medical lexicon added many new words, such as: pulley, wheels, pump, scissors and cords. It had become a commonplace to refer to the ball of the foot, the socket of the eye, the alimentary canal, the pedal extremities and so on, all taken from the vocabulary of the mechanic, you will note, and applied to the human body in accordance with the mechanical contraption that it resembled.

One, Giorgio Baglivi, call him an extremist if you will, devised a little system of his own, giving human functionings a metaphorical turn in which the teeth became the scissors, the chest became bellows, the stomach a flask, the intestines a drain, the glands sieves; in short, he divided the entire human machine into smaller machines and these again into still smaller machines, like the old rhyme of the flea.

It is recorded that another, Edward Barry, anticipated the modern life insurance actuary by venturing to decide upon a man's expectancy of life from the rate of his heartbeats.

Every function of life is the result of a reciprocal action of opposing forces. "Yes" and "No" were created at the same time, and out of the conflict between the two, ideas were born. No theory, whether right or wrong, but has its protagonist and antagonist, and when wrong the antagonist wins the day. The reduction of the mysteries of life to purely mechanical relationships could not long hold water.

A hundred contradictions to every stated rule were observed every day in the drama of life.

You will remember that the fireworks of Paracelsus were noisy but ineffectual, yet out of their ashes was born the science of chemistry. The influence of Paracelsus was too romantic to perish. The mystical cauldrons had sputtered acids, alkalis and salts into vulgar popularity and, incongruous as it may seem, it was a man of the cloth who stole the fire of the renegade to sponsor a new theory of life and health in these scientifically embryonic days.

Jan Baptista van Helmont, Belgian mystic, had been a Capuchin

friar and turned his interests to medicine. He had found that the human stomach contained an acid and a ferment and that these were dominant factors in the process of digestion. Here was a juice, manufactured in a human organ, which was capable of resolving the most varied repast into a homogeneous mass of nutritive material, and yet the stomach itself was unaffected by its action—good cause for reflection!

Van Helmont further observed that a wound exposed to the air festered, and he considered the infection to be due to miasmic substances that entered it.

He made innumerable experiments and elaborated weird theories concerning the dominance of health by alkalinity and acidity.

He first attempted to explain his quandary according to the old Greek theory of sympathies and antipathies, avoiding the difficulty of further elucidation simply by stating that certain substances had affinities for some, and other substances had not.

Then he held ferments responsible for all the changes that occurred in the body and considered them the instigators of chemical processes. This doctrine still did not explain the riddle of life, so he fell back upon the tenets that had inspired his youth. The theology that had fed his adolescence compelled him to be at variance with a purely materialistic conception of man, and struggling with the engulfing waters of unexplainable observations, he clutched at the straws of spiritual conception as we all do when we find ourselves submerged by unanswerable problems.

So he propounded the hypothesis that although physiological processes were, in themselves, purely chemical, they were presided over by a special Archeus, or spirit. This spiritual agency he called the "sensory-motive soul," and oddly enough, he located it in the pit of the stomach (solar plexus) because a blow in that section frequently produces suspension of consciousness.

Delving further and further in his attempt to explain the eternal mysteries, he found himself handicapped and limited even by his own daring broad-mindedness, and he eventually included astrology and mysticism and ancient Egyptian first principles as factors in the production of ill-humor and disease, and like many of his predecessors ended his career by being tried for heresy.

Van Helmont's is only one of the numerous instances in the

history of the pursuit of health, where a whole life and an inspired mentality were dedicated to its problems and where fifty years of energetic devotion to the cause of science brought results that may be stated in a few sentences. But just as the primitive pontoon became the modern bridge, so did the genial and earnest researches of these brilliant pioneers create the sparks from which our modern knowledge and advancement were enkindled.

His protagonists include such famous names as Sylvius and Willis, two great anatomists. But the treatment of disease made little headway and only more and more baffling became the enigma in this period of groping and struggling progress.

The story of these times would be incomplete without mentioning the great French philosopher, Descartes, one of those encyclopedic minds that pondered on all problems concerning the human being. He considered the human body a material machine directed by a rational soul and, illogically enough, while considering the soul a spiritual entity, he gave it a material home and stated that, in his opinion, its habitat was the pineal gland in the brain.

Descartes was among the first graphically to explain the phenomenon of reflex action. All of us have had the experience of having our knees tapped with a rubber hammer, and if we are fortunate enough we respond by kicking the leg forward.

If we touch something hot we draw our hand away before we have time enough to think about what we are doing. These actions which seem to occur independently of our volition are called reflex action. Descartes aimed a mock blow at a person and saw him close his eyes. He described the action as a spontaneous defensive mechanism in which a conscious brain protected, independently of the will, so sensitive and useful an organ as the eye.

He then argued that the brain impulses or vital spirits, as he called them, were responsible for every action and reaction of the body. He was the first to announce a departure from a purely materialistic conception by his great dictum, "I think, therefore I am"; which, in a line, expresses the essence of his philosophy.

A third great influence in the philosophic and scientific thought of the seventeenth century and one whom we can only briefly consider was the great philosopher, Leibnitz, who threw a bombshell into contemporary opinion by disagreeing with the mechanical,

physical and chemical schools and endeavored to place metaphysics as the governing principle of the world. Descartes saw only mass and movement in nature. Leibnitz considered the body merely an image of substance; and motion only the image of action. Mathematics to him explained only the abstract law of possibility. It taught nothing real. Two and two made four but did not explain life. He thought the realization of the intelligible world could be explained only in metaphysical conception. There is, he said, a true primal substance composed of matter and force to which all other concrete elements of Nature must be referred. This substance Leibnitz named the monad. This monad emphasized a pre-established harmony between body and soul as soon as life was conceived.

We must include these great men and unfortunately exclude others, for each one merits a volume to himself. We seek only to show that the scientific Pegasus was carrying many eager riders and that men of varying allegiances, varying character and varying professions were thinking problems before they took them to the laboratories.

There were, generally speaking, five schools of thought, philosophical, theosophical, chemical, physical and mechanical. Sometimes they overlapped and out of the early attempts to combine the chemical and the mystical grew such movements as the Cabbalists, who were half on earth and half in the clouds. The great order of the Rosicrucians also found its origin at this time in an attempt to gain health by correlating necromancy, alchemy and a primitive theosophy.

In the background, still seeking surcease through primitive and superstitious methods, were those tens of thousands who pinned their faiths to the "King's Touch"—a power which a number of monarchs found very useful in aligning themselves with Deity. The efficacy of the good old "Royal Thumb" was vouched for in many lands, and was a custom revived from time to time to give "His Majesty" a new clutch on waning power. The ramifications of this chaos greatly amused the writers of the time and Molière wrote several of his most brilliant travesties on the subject of medical follies and the preposterous peccadillos of physic.

Out of such background came that classic parade of individualists

and iconoclasts whose names have come down through history—Copernicus, with his revelation of planetary revolution around the sun; Galileo with his telescope; Descartes with his analytic geometry; Torricelli with his barometer; Sylvius with his ferments. And Newton, sitting beneath the well-known apple tree until a bit of fruit hit him on the head, found cause to ponder on his revolutionary theory of gravitation. Thereafter, parking space under apple trees began to be at a premium, for there are always any number of people willing to be hit on the head in the hope that some new idea might accidentally be knocked into otherwise unimaginative craniums.

Surrounding these abortive, though earnest, attempts at laying the egg of science was always the unsuspecting public for whose benefit these great and original mentalities were giving not only their time but their very lives. The man in the street was the victim of the best efforts (frequently misdirected in his behalf) by the doctor who was as much confused as Perseus in the labyrinth. Still, honest error sown in earnest purpose frequently brings forth its crop of eventual truth. One need only read the diary of Samuel Pepys to know that ill health was not a thing to be enjoyed in those days. Yet, in his rebellion against the traditions of the past and in his determination to cull truth from experiment and experience, man did achieve considerable progress and the story of health marches on.

What the times needed was an ounce of rationality; and since the history of civilization is largely the story of the right man at the wrong time, there appeared on the scene one Thomas Sydenham, an English physician, whose keen insight, accurate observation and wise counsel threw the beacon of common sense on this very complex situation.

"Let them go ahead with their scientific putterings," said Sydenham. "I am going to try to heal the sick." And so, while war of opinion raged within earshot, he gave little heed to it. Happily for the story of health, he kept himself aloof from the theories and speculations crowding about him. He was interested only in the individual patient and his specific illness and he enlisted his talents in studying the nature, the cause, the clinical picture, the complications and the consequences of the ills that flesh is heir to. He fol-

lowed the Hippocratic method of first seeing, then studying and lastly concluding. He was the servant of his own eyes and his own ears and his own common sense, and had that infinite capacity for painstaking and accurate observation that is the keynote of genius.

Some diseases, he noticed, came quickly, and went quickly. They were acute. Others, like "wounded snakes," dragged their slow length along and damned the afflicted to remain a host to their scourge for a long time. These he called chronic.

He noticed that at times a disease would spring up in an isolated case, here and there, and at others it would run rampant through the country and slay with unreasoning hand. He called the first instance sporadic, the second epidemic, and taught that at times the same disease may appear in either form.

Familiar with life and familiar with death, he saw that the arch-fiend with whom he battled either laid an insidious siege to his victim or slew with swift and sudden stroke. So he said that certain maladies were benign and others malignant, or that the same malady at varying times might assume either form.

Case upon case aroused his interest, and it was his custom to make comparisons and careful study until he was able to give a vivid picture of what had happened in each incident. And that is the reason why the writings he undertook later in life have become valuable textbooks to this day. Thereafter, a less observant and a less capable medico was able to solve many of his medical problems merely by referring to the excellent descriptions of disease given by Sydenham.

Yet among his fellows, most of whom were reaching out for the moon, he had little standing. His educational background had been limited. He had but little university training and had been a captain of the horse guard in the British army—a fellow to whom they referred as "the trooper turned doctor." His contemporaries frequently looked upon him as narrow-minded and bigoted, leaving him so completely alone that he felt the situation bitterly, often complaining of their neglect. So he buried himself in the pages of his four favorites—Cicero, Bacon, Cervantes and Hippocrates! It was to the latter he turned for his guidance in treating human ills. He grew more and more impatient with theorizing and experimentation, joining his voice with that of the great Greek in calling upon

the world "to go back to nature." Simplicity was his theme. He did not have a great respect for the ramifications of human opinion. "The mind is fallible and its scope is limited," he would say. "Yet men call upon a point of view to solve problems in which it is so easy to err."

His attitude on human ills, he expressed tersely in the following manner: "Disease is no more than a vigorous effort of nature to throw off morbid matter and thus recover the patient. Nature provides a train of symptoms as a means of expelling bad matter that would otherwise destroy the fabric."

These broad and empiric principles, unscientific as they may seem to-day, were of far greater import to his particular time than all the feverish striving of those who, lacking proper clinical training, flew at conclusions unproved by time and experience. Believing implicitly in Nature's curative powers, he applied the same simple methods to his treatment that he did to his observation. Vegetable preparations were the chief ingredients in his medicine chest and he advocated sunshine, fresh air, exercise, baths, simple diets and ample rest. "The best thing for the inside of a man is the outside of a horse," he said.

It is rare indeed to find a large brilliant that has not its blemishing flaw. Sydenham was a most valuable balance at a time when mental stability was so sadly needed in the pursuit and acquisition of medical knowledge.

His clinical descriptions have become classical in medical literature. Chorea, or St. Vitus' dance, malarial fever, gout, measles, smallpox, dysentery and scarlatina, he described and differentiated with such remarkable acumen that their diagnosis, heretofore baffling and complex, was now a comparatively simple matter.

But Sydenham limited his scope in the study of disease to the information that the living body could supply. He was completely out of sympathy with any post-mortem investigation. It is strange to think that so great a physician and so earnest an observer failed to recognize the fact that the study of diseased tissues after death might be of immeasurable value in the diagnosis and understanding of cases clinically similar. The dead were beyond help as far as he was concerned and could contribute nothing from which the living might learn.

Sydenham had an enormous practice, and perhaps he was too busy to follow his cases to autopsy and with human frailty discouraged the thing for which he himself had no time. Had his mind been enlisted in the study of tissues after death there is no doubt that the science of pathology would have made as much progress as the science of clinical medicine under his vivid and vital understanding.

But time and tide are stilled by no man, and there were sermons waiting to be preached by human organs after life was extinct. The post-mortem was bound to come. It came in science, as it does in bridge, as the inevitable result of faulty playing. Death was taking too many tricks. It was only natural that, sooner or later, some one would begin to wonder about the mistakes in the game of life.

As usual, there were the players and the "Kibitzers." A Kibitzer is a fellow who stands behind the chairs of the players and tells them what their mistakes were, when it is too late to do anything about it. He is, as every one knows, the public nuisance around every club card room. He is sure to be able to tell you—and does—just how you should have played. But he always tells you afterwards. In cards, there can be a new deal and the hand replayed to prove a point. But once a man is dead, it does little good for a Kibitzer to come around with sage advice about how the case should have been treated.

It was a young Italian, named Giovanni Battista Morgagni, who determined once and for all to drive the medical Kibitzers from his preserves.

Science, as we now all know, postulates theories, the solution of which is as final and exact as the Q.E.D. of geometric problems. It presumes that all circumstances of the problem present themselves again and again in the same way, so that once an answer is achieved, it remains permanent.

And the presentation of these unimpeachable solutions was Morgagni's contribution to the story of health. Time after time he studied the organs of the human body as they appeared in death and linked his observations with the clinical picture of the patient who was afflicted with the mortal disease. Morgagni was the "Father of Modern Pathology" and his results were gained through

GIOVANNI BAPTISTA MORGAGNI

the scientific development of the post-mortem. There was nothing particularly new about cutting open a dead body to learn the nature of the disease, but there was something startlingly new in holding a post-mortem to track the devastating march of disease through the tissues and organs of the body, and to establish its source, its progress and its conquest of human life.

To-day the student of medicine is expected to walk into a room wherein is displayed an assortment of human organs and by looking at them and examining them, give a pretty clear picture of how the one-time possessor of that organ had lived and died. Morgagni was not taught these lessons. He had to find out for himself. And to learn what he learned he had to apply the scientific principle of observing, over and over again, the reoccurrence of phenomena. In other words, he would go to the bedside of a dying man and closely study the symptoms and signs of his malady. After death, Morgagni would hold his post-mortem. Taking each organ into consideration, he would note the changes that disease had made in it. This knowledge of change in human organs during disease has developed today into the most practical basis of treating ills.

Morgagni had to make test upon test, finding how the symptoms dovetailed and what the similarities chanced to be, before he could hazard any decisions. It is due to this intense patience and untiring persistence that he rises as the logical figure upon which the modern stage of science raises its curtain.

Morgagni had come to the University of Bologna, one of the scientific centers of the world of that time, from a little province not far away. His father had died, and his mother, feeling that her greatest task was bringing up a worthy son, had made every effort to give him a good education. He was fifteen years old when he arrived at the university. One of the most famed professors, Valsalva, seemed to recognize his unusual precocity and made the youth an assistant in his dissection classes. At the end of his four years' training, young Morgagni had won a reputation that caused his teacher to trust him with the teaching of the class on many occasions. The strain of study had been too much for the boy, however, and his health was in jeopardy. His eyesight became impaired and finally he had to go home for a long rest.

The modern medical student and pathological anatomist have

their material served on marble slabs in a well-ventilated amphitheater. The cadaver is embalmed, the vessels often injected to make them readily visible, and preservatives and deodorants are generously used to overcome the stench of decaying flesh. Moreover, there are rubber gloves, running water, electric lights, antiseptic soap and all the improvements that contemporary progress has furnished. But imagine the trials of the young Morgagni, sweltering in an ill-ventilated cellar, and in an Italian summer, making his painfully exact dissections by the light and heat of guttering candles. No air but that contaminated by the foulest putrescence; no running water; no knowledge of bacteriology and the nature of infection. No thought of self-protection, he faced disease and death in a dozen ways every day.

When he had regained his health, he went right back to his martyrdom to continue his fascinating researches. In the course of time there appeared a volume, "The Seats and Causes of Disease," a book which completely revolutionized former methods of thinking, and established all future systems of tracing diseases to their origins.

By way of illustrating his methods, let us relate a typical incident: One day, there came a man who complained that he could not stop sneezing. He had been sneezing for days. The attacks were becoming so violent that he could scarcely get his breath. Then, after a particularly prolonged attack, the man died. At an earlier day, some one would have said that he died from sneezing and let it go at that. Not Morgagni! What, he wondered, was there about sneezing that could produce death? It seemed incredible that the act itself could be responsible. There must be some deeper cause. He made a few experiments with his students, tossing pepper, or some other irritant, in their noses and noting their reactions when they sneezed. The spasmodic contraction of their diaphragms gave him an idea. Surely there must be a relationship between the nose and the diaphragm, he reasoned, so he turned again to the corpse and tracing step by step the intercommunicating nerves, found that his supposition was true. The contact was established through the phrenic nerve which supplies the diaphragm and the olfactory sensory branches to the nose. Now the diaphragm, being a major factor in respiration, doubtless had

become exhausted in the case of Morgagni's sneezing patient and the man had died of respiratory paralysis.

Morgagni had innumerable other opportunities for making similar investigations, all of which upheld his conclusion that one cannot make snap judgments regarding the intricate nature of many maladies. Thus, it had been held for countless centuries that all sudden death was heart failure. A man would be walking along and would suddenly collapse. On the face of it, it would seem to be a heart attack, but it remained for the German scientist, Wepfer, to suggest that a broken blood vessel in the brain was often the real cause, and for Morgagni, in his post-mortem investigations, to corroborate Wepfer's conclusion.

You have to trace things back to their source, Morgagni would tell his students, even if the entire body has to be charted in this search. You cannot jump at conclusions. He demonstrated how many erroneous theories had been founded. He pointed out, for instance, that palpitation of the heart does not of necessity mean a cardiac disease but may be secondary and gaseous distention of the stomach or depend upon emotional disturbances.

The conditions preceding death are many and various, and so protean in their nature that the autopsy must have opened a veritable museum of abnormality and a mine of information to the prying Morgagni. He described and classified his findings so accurately that an everlasting foundation was laid for the study of morbid anatomy and its kindred sciences.

In the last valuable phase of his contribution to posterity was the road opened to the solution of future criminological problems. The post-mortem reveals to the pathologist the nature of the lesions in the tissues produced by the poison, and the chemical investigations of the toxicologist will disclose to a nicety the exact substance employed.

But in the days of the Medicis and the Borgias, even though it was generally known that murder was being perpetrated on a wholesale scale, there was no way of searching into the human interior and bringing forth the unimpeachable truth. And there was no way of tracing the effects of the lethal libations and, from this knowledge, creating an antidote. The royal courts of more than one reigning family dripped with the blood of sinister crimes which

were shrouded in mystery because there was no way to prove the exact cause of death.

To-day we know that, in the final analysis, man dies from three causes:—failure of the heart, failure of respiration, or the sudden halting of brain processes. A child may be said to die of scarlet fever, but actually the poisoned virus of the disease has affected the heart and caused death. They say of a man that he was "hanged," but we know that the cause of death was the sudden compression of the medulla oblongata, producing paralysis of the cardiac and respiratory centers. And for this ability to see beyond the outer indication, we are indebted to Morgagni, brilliant pioneer.

Once this seed of search had been planted, it began to produce interesting and important results in other quarters. Morgagni's native contemporaries did not follow his lead with any additional brilliant findings, being satisfied to learn his methods and adapt them to broader clinical use. Morgagni himself lived to be eighty years old, his life brimming with effort, and his mind glowing with inspiration achieved an immortal place for him in the story of health.

CHAPTER XI

Science Cracks Its Shell

Our scene now changes to a little hamlet in Austria, where a lad by the name of Leopold Auenbrugger was helping his father at small tasks about a busy inn. The older Auenbrugger had for many years been a thrifty middle-class innkeeper with a cross-road tavern, just outside the city of Gratz.

It was one of those modest concerns where the entire family is pressed into service. At an early age, little Leopold was given the job of measuring the contents of wine and beer kegs. Faced by the solid wood exteriors of these containers, the lad asked his father how one went about getting this information. "By tapping them," his father probably informed him. "You take your hand and slap it along the barrel and listen closely. Where there is air, you will notice that the sound is entirely different from those places where there is liquid, and you can mark the exact dividing line."

It was not long before the boy became expert at these tapping tests. And from this accident of childhood training came another of the world's important discoveries. Many a year later, when Auenbrugger had finished his university training in Vienna and was experimenting in medicine, he had good cause to remember his father's wine cellars. Many of his fellows came to consider Auenbrugger a little bit queer. They would laugh at him as he went about tapping his fellows on the chest and listening. One day, while engaged in holding a post-mortem on a man who had died of tuberculosis, he investigated the condition of the victim's chest. He tapped about for a time and then he injected water into the chest and tapped some more—and listened! And he noticed the difference in sound where the lungs were full of air, and where they were compressed and displaced by the fluid. He did the same thing on several occasions where pneumonia had been the cause of death. Thus he discovered the condition of consolidation, and the presence

of pus in the pleural cavity. It so happened that tuberculosis was rampant in Austria at the time. Thousands had returned from the wars undernourished and exhausted. Living conditions were bad; there was a great deal of poverty with its attending malnutrition. The opportunities for observation were excellent for a student whose interest directed him toward a study of phthisis. Working in hospitals, and in general practice as well, he made test after test with his finger tappings and reached the conclusion finally that when there was air in a healthy chest, the sound resembled a "padded drum." But where air was lacking and congestion had set in, there was a "dull" sound like the tapping of a finger against the thigh.

One day, just ten years after he had entered hospital work, there appeared a little booklet under his name entitled, "A New Discovery That Enables the Physician from the Percussion of the Human Thorax to Detect Diseases Hidden in the Chest."

Following the precedent of scientific agnosticism, Auenbrugger's discovery attracted but slight attention and was first looked upon with considerable disfavor. Doctors, above all men, should be immune to scientific bigotry and yet the art of physical diagnosis was retarded for many years simply because they refused to accept information which found its origin in so lowly an environment as the wine cellar, and was to be applied to the high domain of bedside diagnosis. Here and there, one or two distinguished men considered it favorably. Auenbrugger himself was probably unconvinced of the infinite value of his method and as his life was one of broad cultural attainment, he took to music and literature as a channel of exit for his scientific disappointment, and wrote an opera called "The Chimney Sweep." Her Majesty, the Empress Maria Theresa, persuaded him to devote his time to writing for the theater, but his blunt reply was, "Your Majesty, I have done a much better thing than writing an opera." It seems, however, that life among the artists and musicians and the cultured group of the royal circle, was more pleasant than the wearisome existence in hospital wards, and Auenbrugger carried his discovery no further.

The art of percussion, which is really music's contribution to medical diagnosis, has become one of the most important methods of clinical investigation. The doctor to-day relies upon it most exactingly, and before the very modern era of X-ray revelation

the delicate artistic tapping of the chest and abdomen enabled him to determine the size of the heart, the condition of the lungs and the position and contour of the abdominal organs. Two factors are concerned in percussion: one is the sound elicited; the other is the resistance that the finger detects in tapping over the lungs, solid organs or fluid. At times when all other clinical signs are negative, percussion will detect inflammation and new growth in the chest and abdomen and enable the physician to arrive at a diagnosis. Percussion has also been applied to the skull, and where there is increased fluid within the brain a characteristic note is elicited.

The work that Auenbrugger had so auspiciously started was left to be carried on by others. First and foremost among them was René Théodore Laënnec, a French physician whom an ironic fate designed to die of the very disease he had hoped to help conquer. He took the helm that the Austrian had relinquished and steered further into the mysteries of the diagnosis of disease. Just as Auenbrugger's discovery came from the application of an apparently trivial fact, so Laënnec, from casual observations made in his youth and in later life, brought and enlisted a most valuable method to the defeat of disease.

He was born in Brittany, 1781, and became a delicate, fragile child requiring great care in his upbringing. He was taken by his parents to a small town, which was almost entirely hemmed in by an oak forest, so that he might thrive in a sheltered locality and be given the benefit of outdoor life. Toys were not as numerous as they are to-day nor as easy to obtain, and the logs that the woodmen had felled were symbolized into playthings with which he and his playmates diverted themselves. Inventing a primitive method of telegraphy, the children found that by tapping one end of the log and listening at the other, they heard the sound clear and intensified. In later years, while taking a stroll in the gardens of the Louvre, he noticed boys and girls sending signals down a piece of board by scratching one end with a bit of metal.

Laënnec was struck with the idea that if sound could thus be carried, a wooden cylinder should intensify and reveal the faint sounds developed in the human body. So was born the stethoscope!

At the age of nineteen, Laënnec had gone to Paris to study medi-

cine. One of his tutors chanced to be Corvisart, and Laënnec became his favorite pupil. Corvisart was startling the academies by teaching the Auenbrugger method of percussion, although nearly fifty years of neglect had passed since it had been announced. In fact, it might have been entirely neglected but for Corvisart's resurrection of the method. He taught it to Laënnec, and it was to his mentor that the young pupil entrusted his idea of the stethoscope, and was due to his teacher's encouragement that he was persuaded to carry out his theories to their fullest expression. Incidentally, Corvisart was Napoleon's personal physician and a very important influence in the life of the "Little Corporal."

Quaint indeed are the early comments of Laënnec upon the new method that he was sponsoring in the diagnosis of disease. The beating of the heart is audible to the naked ear placed upon the human chest, but slight and fine variations from normal signs are apt to remain unheard; and so had diseases of the valves attained, in many instances, a considerable degree of advancement before they became manifest to the clinical ear. Where a diagnosis is made very early in diseases of the heart, years of life are added to the patient by prompt attention to his malady. The same holds true in many diseases of the lung, especially tuberculosis.

To quote Laënnec's own words concerning his discovery, "In 1816 I was consulted by a young person laboring under the general symptoms of a diseased heart. In her case, percussion was of little service because of her stoutness." So modest were the medicos of that day that they seemingly did not consider it proper to place either their hand or their ear in the neighborhood of a young woman's breast, for, says Laënnec, "The method of applying the ear to the chest wall was rendered inadmissible by her sex. I happened to recollect a simple fact in acoustics; the fact I allude to is the distinctness with which you can hear the scratch of a pen at one end of a piece of wood while applying an ear to the other. As this idea came to me, I rolled a piece of paper into a cylinder and applied one end of it to the region of the heart and another to my ear. I was not a little surprised to find that I could thereby detect the heart action in a manner much clearer than ever I had been able to do before. From that moment it seemed to me that this circumstance might furnish a means for ascertaining not only the

action of the heart, but, by every species of sound produced by the motion of the thoracic viscera, a means for exploring the respiration and the voice. With this conviction, I began a series of observations from which I have been able to deduce new signs of disease in the chest."

After this preliminary activity, Laënnec went about proving his method and spent two years of intensive study. Out of the roll of paper originally used came first the wooden cylinder and then the stethoscope so familiar to all of us who have ever had a medical examination.

So much for the cold, unemotional biographical overtones of his achievements and story! The inner man provides a sermon in sacrifice to humanity and heroism to purpose. Laënnec died for Man as surely as did the Christ he so zealously followed. His health had never been good. At an early age he found himself broken, the victim of an acute melancholia, a neurasthenic and a potential tubercular. He left Paris and went back to his open country. There his health was partially restored and, by remaining, he doubtless could have prolonged his years and conquered his physical disabilities. He knew that returning to the city meant risking another and more serious breakdown. Yet, because Paris offered him his opportunities to work for human welfare, he went. He associated himself with the hospitals, attending hundreds of bedsides at a time when his condition was, perhaps, little better than the patient's—if as good. He defied strain and fatigue, nor did he give attention to the dry cough which for four years slowly magnified itself into hemorrhage.

It cannot be said that amibition goaded him, for there is plenty of proof that he was content with achievement for its own sake. Seldom has there been a man of simpler desires. Although he had been made court physician to a duchess, he abhorred the gold braid and other paraphernalia that went with it. When others rode in stately carriages, he modestly hired a cab. There was no pomp or ceremony about this man! And, as he went about ministering to the suffering, he suffered much himself because the limitations of human knowledge made some of his efforts so futile. He kept up these ministrations until too weak longer to resist. He knew death

was coming and so informed the loving family that had gathered about his bedside.

To-day we accept as a commonplace the simple-looking instrumen. the doctor puts to our chest as he remarks, "Breathe again—deeper this time!" and the most subtle insinuations of disease are revealed to him. Sight and touch had been the only mediums of clinical information, and when Laënnec added the human ear to the Science of Diagnosis, he developed probably the most powerful weapon against the insidious tiptoe of the Angel of Death.

It is an old truism that the cart frequently precedes the horse. Even to-day in our advanced state of scientific knowledge, we know much more about the abnormal than we do about the normal; and so in the eighteenth century, when science was cracking its shell, a great deal was being said about disease in the human body while normal processes were little investigated and less understood. It was at this time, however, while diseases of the lungs were being diligently described, that a small army of thinkers was investigating the nature of the air we breathe and what happens when we breathe it.

Out of their combined efforts, and his own, the Frenchman, Lavoisier, who had never heard of chest tappings, produced a little monograph in 1777 entitled, "Experiments on the Respiration of Animals," which clarified the diffused subject. Lavoisier, a scientist lost in the maelstrom of the French Revolution, had harvested the crop of knowledge sprung from the seeds sown by the pioneers of the search in the mysterious realm of respiration. Just before him, Joseph Priestley had barely missed the bull's-eye and, before Priestley, had been a parade of earnest workers who were defining "specific heat," and "latent heat" and "body temperature." Another group of chemists had been trying to reduce the contents of the air to its chemical symbols, or had experimented with artificial respiration and combustion.

Whereupon, Lavoisier stepped upon the scene with an accurate explanation of the exchange of gases that takes place in the lungs. Such minor errors as he might have made were corrected by his successor, Laplace, the astronomer, who showed the analogy between the respiratory process and combustion. By that time, however, Lavoisier had already paid the penalty exacted by the French mobs,

whose revolutionary fanaticism caused them to regard a scientist as an enemy. Wherefore, the brilliant head of Lavoisier came off under the guillotine.

What Lavoisier had discovered, any schoolboy learns to-day as a primary lesson in physiology. Briefly, it is this: every animal gets oxygen from the environment in which it finds itself. A fish can extract it from water and a bird can extract it from a high altitude. Man takes in air through his nose and mouth. When it enters it contains oxygen, nitrogen and carbon dioxide in certain proportions. At this point the amount of carbon dioxide is small and the amount of oxygen greater. When the breath is exhaled, the carbon dioxide has multiplied many times and the oxygen content is less. On the intake of the breath the oxygen becomes separated from its companion gases and passes through a thin membrane into the blood stream, and is thus carried to the living tissues, in the normal course of energy production. Thus it provides a perpetual fuel which feeds the tissues with the fire of vitality and is eliminated and expelled in the form of carbon dioxide, with some water—as you may have noticed when you "saw your breath" on a mirror or window pane.

When these facts finally were revealed, the usual flock followed the wake of the pioneer. All the straw-clutchers now grasped at oxygen breathing. A new group of cults appeared. Every faddist tried to turn the new discoveries into a health vogue. From a dozen newly created leaders came the declaration that disease was caused primarily by either an undersupply or an oversupply of oxygen. From these groups finally came the "Pneumatic Institute," which treated illnesses by "methods of inhalation" and laid the foundation for all the breathing fads which have since enjoyed popularity. Oxygen became the panacea. And, about every twenty-four years, it is revived; only recently one could have seen cases of pneumonia exposed to the naked elements.

Now came discovery from a new and highly unexpected quarter. This time it was a literal "bolt from the blue" that opened a new field of thought. When our own Benjamin Franklin, with his kite and his key, anticipated such nuisances as door bells, he also provided science with a new weapon. In America, electricity was leaped upon at once as a possible aid to health and static machines

were in the Middlesex Hospital long before Bunker Hill loaned its historic prestige to Boston. But they went no further.

And so the scene shifts to Bologna, Italy, once more and here we find a love-sick student, kneeling at his shrine and seeing, instead of the Saint before whom he prayed, the lovely face of his professor's daughter. His name was Luigi Galvani. He was a student of such promise that the famous Professor Galeazzi gave him not only a home, but also a wife, in the person of the brilliant Lucia Galeazzi. History is full of shrewd guesses concerning what part wives may have played in the rise and fall of famous men, but there is no doubt in the case of Galvani. Lucia was, seemingly, an intellectual match for her spouse and, according to the best and most popular legends, actually made the discovery for which her husband has been given credit. Feminists are given carte blanche to do what they will with this tale.

Galvani had been working on various problems in comparative anatomy. His laboratory was cluttered with birds, alive and dead; frogs, half-alive and dead, and other creatures. One evening, a party of scientists dropped in to talk with Galvani about his work. They were taken into the laboratory where Galvani picked a few of his favorite frogs from a jar and showed the visitors how he had skinned the legs and studied the muscles. As his conversation warmed, he dropped them on a table, where they wiggled about as best they might. Now, it so happened, that upon this same table there was a little machine for generating frictional electricity and the conversation drifted from the frogs to the machine. Galvani explained that, by this frictional process, electrical sparks could be made to shoot about. His callers expressed curiosity and one can imagine Galvani turning to his wife and saying: "Dear, would you mind turning on the machine?" Whereupon the fair Lucia dutifully obeyed. This was indeed a fateful moment projected into the most casual sort of a scene. A couple of frogs had dragged themselves into the general spark zone. When the machine was turned on, Mme. Galvani picked up a metal scalpel that chanced to be lying on the table. The scalpel touched a frog's hind leg. At once the frog went through convulsive movements. Like a dutiful wife, she called her husband's attention to what had happened. The scientists gathered about the table. Again the machine was turned

on and again the scalpel was applied and again the frog engaged in its contortions. Still unsatisfied, Galvani rigged up a lightning conductor, connecting it with his laboratory by means of a wire. Waiting for a good electrical storm, he attached the legs of a number of animals to a metallic circuit and sat back to observe what happened when the lightning struck. Thus came about knowledge of the muscle nerves and their reactions to electricity. In our own day, we have merely to turn to the lurid tabloid descriptions of the latest electrocution to get a mental picture of Galvani's discovery.

Among his contemporaries, the scientist and his experiment were the butt of many a joke, and the cause of many a laugh. They came to refer to him as "the dancing master of frogs," and could see no sense in what he was achieving. But he was not discouraged. Not only did he keep up his experiments, but he began to ponder the problem of electricity contained in the human form. He began with luminous fish and wound up with his theories on animal electricity, which Alexander Volta, a professor at Pavia, was quick to follow up with his experiments in muscular contraction under electrical stimulus.

What he had been striving to do can be summarized briefly as follows: Galvani wished to prove that the shocks felt from sparks, artificially produced, are the same as those produced by natural electricity—and thus did he lay a foundation for modern electrical knowledge; he wished to demonstrate that electricity exists in the living body and that the sparks could pass into the living animal, as well as into the inanimate metal; that this animal electricity might account for various human phenomena and that there is some relationship between electric currents and nerve impulses—an idea which is still getting its quota of attention.

It was for him that the galvanic current was named, just as it was from Volta that we get our word "volt."

To-day, thanks to Galvani's pioneering, every well-equipped doctor's office and hospital clinic is provided with a dozen and one little instruments in which galvanic cells or currents play a part and in which batteries and mechanisms combine to furnish a medium for aiding the physician both in his diagnosis and in his treatment. It also enabled Edison to give us electric lights. In the glass cases of the modern physician, and carried in his little mysterious black

bag, are contrivances which throw a penetrating pencil of light and make it possible to peer into the eyes, ears, nose, throat, urethra, bladder and rectum. Even the bronchi and esophagus may now be directly seen.

Even as the one-lunged horseless carriage of the 90's has become the "straight eight" of to-day, so did many of these instruments of precision begin as very primitive expressions of new fields of endeavor and eventuate into startlingly accurate and complex mechanisms, the employment of which has carried the practice of medicine into many fields of specialism. Only recently by the use of radio and intensifiers, the heartbeat was broadcast with astounding accuracy to listening ears far removed from the patient.

Back in the eighteenth century, the development of a trustworthy watch led the way to the first accurate observations of determining the pulse, but there was no method of measuring human temperature. Man had to depend upon his untrustworthy sense perceptions to determine between heat and cold. In art works left behind by the Greeks and the Romans, we find the human foot being used as a thermometer for testing the temperature of the baby's bath. This custom has not entirely gone out of style. When going in bathing to-day, we have a habit of first wriggling our toes in the water to see whether it is too chill.

Barometers and climatic thermometers were first invented. Galileo made a crude bulb instrument that could be placed in wine or water. The alcohol thermometer was the next step. But it was a young German, Fahrenheit, who brought it to a final state of perfection. He became interested in the study of temperatures while a student in college. His teacher, Hermann Boerhaave, who founded the eclectic school of medicine, had been conducting tests to learn how long various animals could withstand various degrees of heat. Necessity again became the mother of invention and the clinical thermometer was born.

The laryngoscope, with which the throat is examined, came from a Spanish singing teacher, Manuel Garcia. As a trainer of voices he had, quite naturally, wondered about the disturbances that put the frog into the throat. He would peer into the open mouths of his pupils, but could ascertain little. Then the idea of an inverted mirror came to him and soon he was able to get the necessary re-

flection, and see the movements of the vocal cords. Medical men soon availed themselves of the method and the hidden interior of the larynx became visible and accessible to treatment. To-day, the larynx is made visible by direct illumination and even the bronchi can hold no secret from the prying eye of the diagnostician. There was a time when "swallowing a thing the wrong way," and having it lodged in a bronchial tube was a very serious calamity, ending inevitably in infection and death. To-day, a foreign body can be visualized and removed with the help of the bronchoscope and the X-ray.

Of all light-reflecting instruments, the ophthalmoscope, which is used to examine the human eye, was first in importance. The idea, like so many others, was both spontaneous and accidental in its origin. Hermann von Helmholtz, of Potsdam, was an infinitely capable scientist who, after a varied career in chemistry and laboratorial experimentation, became a professor at the University of Königsberg. He had been preparing a paper for his class on the theory of reflected light. He relates in his memoirs: "As I prepared my lecture, I began to ask myself what optical maze was reflected from the luminous eye." The question had flashed upon him quite out of a clear sky. He wondered what would happen if a light were thrown into the back of the eye for the purpose of examining the retina. He made a crude model out of a piece of pasteboard and he availed himself of old microscope lenses and mirrors. Using a strong light as his source, he threw a beam of light into the human eye, gazing at it, when, lo and behold! its wonders were exposed to him!

To-day, as we know, the physician, with eye squinted at a tiny hole, can peer into the human eyeball and not only locate optical disorders, but actually see the optic nerve and the retinal vessels which give most pertinent clews to many systemic diseases.

It might be noted at this point that for centuries the problem of eyesight had never been deeply penetrated, although spectacles have been traced back to the early Chinese. In the snow-covered north countries, "snow glasses" had been used for many a year. The attitude toward the blind had been incredibly inhumane. The ancient Orientals had used them as masseurs, but the Europeans of the seventeenth and eighteenth centuries had let them go begging

in the streets, or used them in carnivals, circuses and other entertainments. It is related that, in France, there were so many blind beggars in the streets that each day they battled for places in the alms lines. On fête occasions they were dressed as clowns, or costumed in masquerade attire to be turned loose, stumbling and fumbling about, falling and bumping in their eternal darkness, while the crowds laughed merrily at what they considered funny antics. Every generation, it would seem, has its peculiar sense of humor.

At any rate, the philosopher Diderot became so distressed at their plight that he decided to help them. He began to study the keenness of their other senses and published an essay showing how amazingly adaptable they were. He suggested that they be taught trades in which they could use their agile fingers. He urged that they be taught to read and write by means of letters raised on paper. The government authorities were highly incensed at Diderot's writings; he was arrested and thrown into the Bastile for his suggestions. But he did not give up his ideas and, when visited by the great Rousseau, outlined a method for teaching the blind to read. Half a century later, one Valentin Haüy, also touched by the inhumane treatment accorded the blind, selected a number of sightless men and women and opened a small institute where he taught them music and various trades, also providing them with schooling. When he had proved their virtuosity, he presented them to King Louis XIV, who was greatly impressed. And thus started the modern institutes for the blind. The romantic miracle of Helen Keller, who conquered a sightless world by genial attainment, will ever be a monument of glory to those who first felt the charitable urge of helping those whose "light had been spent."

Mechanically, then, Man had done very well in overcoming handicaps that stood in the way of his endurance race with Time's ravages. He was slowly trying to put together the odd bits of the jig-saw puzzle that would enable him to look at himself as a complete pattern. Let us not forget that he did not know in the seventeenth century how the human stomach digests its food; nor was he aware that the frame he lived in and the machinery that made it go were made up of millions of little living worlds, which we call cells.

It was by the sheerest accident that he stumbled over the first,

and by the grace of the microscope that he discovered the second. Those earnest missionaries of human welfare that we have classified as chemical, physical and mathematical school cultists, had been doing the best they could, considering the equipment with which they had to work. Innumerable queer theories had been held concerning what happened to food, once it had been chewed and sent on its journey through the alimentary canal. No one had ever seen a human stomach actually in operation. The X-ray had not been dreamed of and there seemed to be no known way of using an animal for purposes of observation.

So the befuddled scientists could merely sit back and ask themselves how the strange changes in food came about in the process of digestion. Since they could not look at food within the stomach they decided to see what happened to it in jars or test tubes. First an Italian, named Redi, wondered why food putrefied. Were the destructive forces already living in it, or did parasites come to it? He put bits of meats in jars and watched maggots appear. Next a Frenchman, Réaumur, decided that his pet bird might be employed in the interest of science. So he extracted digestive juice from the kite's stomach, mixed it with bits of food and saw that the food dissolved. Another Italian, Spallanzani, went a step further, securing juices from human stomachs by egestion, and watched food begin to melt in its presence. Others considered the part played by saliva, and still others contemplated the problems of chewing and of intestinal contraction.

Then, finally, just about 100 years ago, in the lonely woods of our own Northwest, there occurred an accident that was to revolutionize man's knowledge of digestion. The setting was in the best manner of the movies. It was a primitive trading station in Mackinac. A half-breed Indian, by the name of Alexis St. Martin, happened to be loafing about the front of the lumber camp store, when a shotgun was accidentally discharged by a customer who was trying it out before buying. Now this fateful shell chanced to tear off a piece of the Indian's abdominal wall, shaving off also a bit of the outer layer of his stomach. (It was, scientifically speaking, the most important part that gunpowder had ever played.) Thus did the merest chance present an opportunity of gazing into a human stomach even as one might glance through a window pane.

Even then, science might have lost its opportunity, because this was probably not the first time a man's flesh had thus been removed. But it so happened that there was attached to the post a young American army doctor by name of William Beaumont. Beaumont was fresh from the universities, and was passing his apprenticeship in this far-away place. Arriving to attend the Indian, Beaumont made the necessary gestures toward saving the man's life by stitching his stomach to the skin. But, even as he operated, the young physician realized that he was in the presence of a circumstance that never had before been presented to any one capable of comprehending it. He had in his keeping that astounding miracle—a man with a hole in his stomach, open to the outside world. And he could study everything that happened. With little to do in this primitive post, the young doctor wasted no time giving most of his attention to a study of the phenomena that fortune had sent into his hands. Day by day he carried on experiments. First he tied a piece of meat on a string and let his patient swallow it. He noticed that within two hours it was completely gone. While this experiment was under way, he kept an eye on the digestive juices as they oozed forth to the stomach's surface. Having watched the play of the juices, he noted that they made their appearance only as food entered or was being chewed in the mouth. He had in his hand the basic principles of the digestive process. Not content, however, he injected a tube into his patient's stomach and secured a number of specimens of the gastric juices, sending them to the University of Virginia for examination. Here for the first time chemical analysis showed the presence of "free" hydrochloric acid. To a major extent the old mystery was now partially solved.

The young Dr. Beaumont, however, soon discovered that carrying on experiments with a perambulating specimen had its disadvantages. Realizing that he had in his possession a curiosity of Barnumesque proportions, Beaumont made every effort to keep his freak within constant reach. Alas, the Indian had long since become overfond of the white man's firewater! And, once his wound had begun to heal, St. Martin celebrated with many sprees, disappearing for days and leading the young scientist a merry chase among the trading-post bars.

This made things a bit difficult for the doctor, who not only had

other observations to make but also was hurriedly making notes for medical publication, in order to tell the world what he had learned. Shortly thereafter, the doctor found himself wearied as the result of his combined efforts as frontier practitioner and scientific Columbus. He returned to civilization, there to take his place among the important personages in the story of health. And, if you like a bit of irony with your tales, it might be added that, even as in the rhyme of the dog that bit a certain mean man, "it was the dog that died," just so, the Indian, St. Martin, went on living to a healthy old age, despite his wounds and his hard liquor, whereas the earnest, hard-working scientist went to his grave something like thirty years before his patient. Meanwhile, Professor William Osler, a celebrated Canadian scientist who had become greatly interested in the case, made an effort to keep track of the Indian after Beaumont had died. But St. Martin had taken unto himself a squaw, who resented the intrusion of the medicos. She guarded him carefully until his death and then had him buried under ten feet of earth, so that his corpse could not be disturbed. Osler had wanted the body for post-mortem purposes and had been willing to pay well for it. Superstition, however, barred the gateway to science as it had ever blocked the road to true insight.

Beaumont, however, had given the world just about all that it needed to know about the gastric phase of the digestive processes and St. Martin went to the shades of his ancestors happy in the fact that his corporeal remains were not to be disturbed.

But the name of the mysteries hidden in the processes of life was legion. Speculation had endeavored to explain how and why man thought and felt and experiments in the domain of the psychic were left to the quibbling though profound ratiocination of philosophers, but the body itself was a practical thing and its functions and changes, tangible as they were, intrigued the zealous ambitions of those scientifically inclined.

Which brings us to a poetic-minded lad, lying on a pastoral hillside of a little French farming community watching the ruminant cows chewing their cuds. And as he watched questions began to frame themselves in his inquisitive young mind. Why, for instance, did the cow dine in so leisurely a fashion, whereas the farm hands, running in ravenously from their day's labors, bolted down their

food and quaffed their wine? Why, in fact, did the cow eat only of greens while men ate of meats and fats? These questions were to recur in later years and lead to discoveries of monumental importance.

At the time, however, there were problems of more immediate importance in the life of Claude Bernard. The grape crop had not flourished for a season or more and his family needed his economic assistance. So he took a position as a pharmacist's assistant at Lyons, after a term in a Jesuit college at Villefranche. Claude wasn't sure he wanted this sort of life. The fires of creative effort were smoldering in him. When there was nothing else to do about the pharmacy shop, he would write verses and plays. All about him were youths with literary ambitions. And so he finally wrote a very amusing comedy, "The Rose of the Rhone"; and a tragedy, "Arthur de Bretagne." Young Bernard was now certain that he would become a playwright of importance, and took himself off to Paris to consult with the great French critic, Girardin. Girardin reviewed his writings, patted him on the back and admitted that as a dramatic poet Bernard had evident talent. "But," the critic advised him, even as critics admonish the modern riders of Pegasus, "you are looking for a career. You have had some experience in medicine. It's far more practical than writing. Forget the drama and become a doctor!"

No critic ever gave an uncertain youth better advice. Bernard might or might not have been a good playwright; certain it is that he became a great scientist.

A few months later found young Bernard a favorite pupil of the great teacher, Magendie. The youth was prepared to face every privation; and even hunger was no obstacle to his passion for knowledge. He lived in squalor in a tiny garret of the Latin Quarter, sharing quarters with other struggling students. In this little attic they lived, cooked and studied. Unable to buy kitchen utensils, young Bernard would "borrow" them from the laboratories, turning surgical knives into table knives and measuring glasses, crucibles and such into cooking utensils.

So thoroughly did he put his heart into his work that the day came when the great Magendie himself paraphrased the Tommy's words to Gunga Din, "You're a better man than I am"; and this the

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teacher admitted with all honest humility. For Magendie, like many another excellent tutor, was somewhat of a dilettante when it came to applying himself to laboratorial tasks. Bernard, however, had approached his work in a manner best appreciated by a quotation from his own writings:

"When you enter the laboratory, put off your imagination as you would your coat. When you leave the laboratory, put it on again. Let your imagination wrap you round before the experiment and between whiles; put it away during the working hours, however, lest it hinder your powers of observation."

With such a code, it is little wonder that Bernard became one of the great men of the world! Doubtless he had learned, early in his career, how great a part accident plays in discovery; that, in taking advantage of these accidents of discovery, the factors of prime importance are vivid imagination, the application of thorough knowledge, and tireless effort.

At any rate, one of the first investigations he undertook harked back to the days when he had been a country-boy lying on the hillside watching the cows come home.

His problem concerned itself with the differences in the digestive processes of meat-eating and herb-eating animals. Up to this time, physiology had concerned itself merely with the action of the gastric juices as agents of digestion. Perhaps, thought Bernard, some digestion goes on in the mouth. Perhaps the saliva has something to do with it. Investigation and experiment proved this to be true, namely, that the saliva is a necessary adjunct of digestion in that it partially changes the sugars and starches to a more assimilable chemical structure.

In our own time, Pavloff, the celebrated Russian physiologist, has shown that the flow of the saliva is conditioned to the nature of the food that we eat, flowing to a lesser or greater degree as it is needed either to protect the alimentary canal from too irritating foods or to prepare for digestion the food that comes within the province of its physiological function. The salivary glands, so to speak, are the postilions at the gateway of the alimentary canal. All food must give its countersign to the sensory nerves and the taste buds of the tongue and by that miraculous system of nerve telegraphy, the stomach and intestines are prepared for its reception

before it reaches them. This discovery gave a tremendous impetus to research in the study of the entire problem of digestion. It was found that the stomach had practically no action upon sugars, starches and fats.

Claude Bernard took a rabbit and fed it fatty foods. He found that the fats underwent no digestive change until they had progressed some distance beyond the stomach. Then he took a dog and made the same experiment. Now he noticed that the foods were emulsified almost immediately after leaving the stomach. Bernard pondered on this circumstance and found that in the rabbit the pancreas emptied its juices about nine inches below the orifice of the stomach, whereas in the dog, the secretions entered just below the stomach's juncture with the intestine. The pancreas, he argued, must be responsible, and so he discovered that the pancreatic juices split the fats into fatty acids and glycerine, making their absorption possible. He also found that the pancreas completely changed the starches into sugars and eventually acted as a solvent for all proteids. The importance of the pancreas is vital, as man can live without a stomach, but dies very quickly if his pancreas is destroyed. The time-honored disease of those who feed too well, but not wisely, namely, diabetes, is largely due to an insufficiency of pancreatic function. We know to-day that sugar is the great fuel upon which human energy depends. Claude Bernard forever determined the question of the part that sugar played in the human economy. Up to his time, the theories concerning its rôle were vague and grotesque. Its agency in the production of animal heat and its importance as a factor in nutrition had not been understood. Using the animals for his experiments, Bernard fed them sugar and injected it into them and examined a thousand times the changes that varying sugars in varying quantities produced. Finally, this fact faced him. He had the specimen of blood taken before it entered the liver. He had others of the same blood taken at various intervals after they had left the liver. The liver had been considered the organ that consumed the sugars eaten, when Bernard found that the food, on leaving the liver, contained more sugar than the food that entered it. Then the animals who were fed no sugars at all showed it to be present in the circulating blood. This was the great discovery of the so-called glycogenic function of the liver.

Glycogen is the substance that the liver sends to the muscles to be consumed in the production of physical energy. The structure of the sugar molecule is such that it is completely burnt in oxidation and eliminated as water and carbon dioxide. When this does not occur, diabetes is the result. And so in scientific language came a new term "internal secretion." The importance of this term was to explode the long-held theory that the body was nothing more than a group of organs, each with a separate function. Each organ was like some complex instrument in a great orchestra that contributed its miraculous music to the symphony of life in harmony with all the others, and the whole was presided over by a nervous system that knew every note without looking at the score. Any disturbance in this unison produced discords which interpreted themselves as the symptoms of disease. The ramifications of Bernard's discovery, as it has revealed itself to us in modern times, would have staggered even his imaginative mind. To-day, the glands of internal secretion are subjects of lay conversation far outside the narrow confines of science.

Every abnormality of body and mind is in some degree associated with disturbances in the fine coördination of the glands of internal secretion. We will treat them more comprehensively in another section of this story of health.

Bernard's contributions to scientific discovery would in themselves fill many volumes. One other monumental one may be mentioned.

One day he accidentally cut the sympathetic nerve in the neck of a rabbit. He found a strange change in the circulation to the part affected. The side of the head which the nerve had supplied became hot and congested. The arteries were dilated. Blood flowed more slowly, and the so-called vasomotor nerves were discovered. All life, all activity, calls for varying supplies of blood and the response comes through this system of nerves affected by impulses from each specific organ. Their action is seen in the blush of shame and the pallor of fear and a disturbance in their action is responsible for abnormalities of the function of organs which inevitably lead to structural changes. So do a great many diseases affecting the organs that carry on the vital processes begin in slight aberrations of the bodies regulating mechanisms. And doctors, more and more, to-day recognizing the subtle and pernicious influence that mal-

adjustment has upon physiology, are seeking to prevent disease by attempting to help human beings harmonize their lives to the necessities of their environment.

During his life, many honors were conferred upon Claude Bernard and after his death the garland of immortality was placed upon his name. His life was full of activity and attainment. At the Sorbonne where he taught and expounded his doctrines, preaching the importance of thoroughness and application in experimental physiology, he was a constant source of inspiration to his students.

His own life was not altogether a bed of roses. Spending as much time as he did in research, his personal practice was small and his income limited. He found himself frequently between the devil of domestic difficulties and the deep sea of the antivivisectionists. His wife, unsympathetic to his efforts, prevailed upon his daughters that he was a failure who spent his time in his laboratory vivisecting animals, and she was not the least bit reticent about airing the facts of his experiments to those who have been classified as potentially cruel to human beings and therefore overkind to dumb beasts. So he was constantly being threatened by the police and he would probably have been just as content in a cell if it had been equipped with the instruments of his occupation. He, however, cultivated the close personal friendship of the police commissioner who, convinced of the value of his work, protected him from the persecutions of the community. Without his help Bernard would probably have been unable to conclude his epoch-making discovery. The police are sometimes of great benefit to civilization.

Bernard's work was too great to remain unappreciated and Napoleon the Third summoned him before him and begged the privilege of bestowing upon him any favor that he might ask. "I wish only a better work-shop," said the modest genius. Thereupon the Emperor had two fine laboratories built in the Sorbonne. One of the tables upon which he experimented, by the way, has been purchased by Americans and can to-day be seen at the medical museum at Washington.

Happy accidents are abroad on as many highways as unhappy accidents. To write of men and events without giving some credit to chance and accident is to be unfair to Life and to Fate. Galvani gets credit for a great discovery which came about when his wife

accidentally picked up a scalpel and touched a frog's leg. Bernard, as you have seen, stumbled onto discoveries which enabled him to chart the rivers of "doubt" and "mystery" that trickled through the human interior.

And Johannes Müller found himself on roads which led him to the place of genius he so justly deserves. Müller not only opened the door to the little known world of cells, but led the parade of Germany's modern-day scientific achievement. Many a man has launched a ship which he did not live to sail. And Müller's rôle was as much that of a teacher as of a researcher and discoverer. His students—such men as Virchow, Schwann and Henle—make one of the proudest lists any nation can claim.

Yet a series of accidents gave him his opportunities. Early in life it seemed that Müller would be condemned by economic circumstances to forgo the educational opportunities that founded his career. Müller's father was the cobbler of Coblenz. Cobbling wasn't a particularly profitable business. That is, not until the soldiers of the Napoleonic legions came in hordes to the little city when the left bank of the Rhine had been occupied by the French. Then trade picked up. It approached a prosperous state, and Johannes was trained to carry on when his father died. But, with a little capital on hand, Johannes' mother thought he might be given a better chance. She consulted the boy. He was intent upon mending souls in another way. He wanted to be a priest. The family, being devoutly Catholic, was pleased. He was sent to a Jesuit college. Here some of the older Jesuit priests still provided the students with a classical education. This included the languages—Latin in particular—Shakespeare and, most important of all, Goethe. It was Goethe and butterflies that turned the course of Müller's life.

Like his classmates, he might have continued into the priesthood and disappeared in the candle-lighted shadows of the Church. Instead, he was attracted by Goethe's writings on scientific subjects. It so happened, also, that there was a large countryside about, with flowers and shrubs that attracted many varieties of butterflies. The lad took his net and started out to collect all available specimens. Impaling them upon his wall and looking upon their transient beauty, the imaginative lad began to ponder the mystery of the chrysalis, of the lovely powder that colored their wings and of their

life among the plants. Thus his attention turned toward scientific subjects, and in addition to collecting butterflies he began to study other insects. Because he had an instinctive fear of spiders, he studied them in an effort to explain his own reactions. Physiology was still a young science and its fascinating ramifications captured his imagination. At eighteen he was in Bonn, about to enter a medical school, still hesitating whether or not he should resign his original ambition of theology. After questioning himself thoroughly he decided that the mysteries of the here interested him more than the mysteries of the hereafter, but throughout his life and researches the roots of a deeply planted religious soul were ever in evidence. Having made his decision, he became an avid experimenter in all unknowns. At times this zest amounted almost to fanaticism. Thus he went without food for days in order to make notes on the state of his mind and body during this period. Again, he found bits in Goethe that awakened an interest in "second sight," and would strain hour upon hour trying to force the unseen to appear before his vision; or he would lie in bed at night staring into darkness, trying to conjure up colors and images out of the blackness. Such efforts had the very natural effect of creating a nervous reaction that made him seriously neurasthenic over a long period of time.

Earlier in life, his restless curiosity achieved amusing and laughable results. Genius, it seems, can perform antics quite as comical as asininity. And Müller, engrossed in problems of reflex action, did not rest until he could wiggle his ears to the endless entertainment of his fellows. After perfecting this trick, he practiced until he could dilate the pupils of his eyes at will, rehearsing for hours before a mirror. He was, indeed, a strange lad! Years later he was to introduce the doctrine of reflex action, already indicated by several scientists, to the knowledge of physiologists.

With maturity at hand, and a bit frightened by his nervous collapse, Müller suddenly cut completely loose from his mystical and introspective experiments and went in for more concrete anatomical research. First he performed experiments on the spinal nerves, discovering a new and simpler method of attempting such experiments; then he turned to a study of the blood and the red corpuscles, demonstrating the composition of the blood. The structure and anatomy of the glands next held him. He stood apart from his

fellows in his amazing exactness and widely varied explorations. Perhaps his one-time student, Virchow, summed him up in an essay of appreciation. when he said: "Müller did not discover, but he firmly established the exact method of investigating natural sciences. The school of natural science which Müller created knew no community of doctrine; it knew only facts and sound methods." His fault, perhaps, as a creative scientist lay in the fact that he had too many varied interests. He wandered from pathology to paleontology, working with the great Agassiz; he penetrated the world of natural phenomena, from parasites to personalities, constantly attempting to solve the riddle of life.

Virchow was inclined to believe that, after all, Müller had become a priest: "A priest of nature." Certain it is that he had a most loyal congregation and one that followed him as zealously as it would have followed any Messiah, scientific or otherwise. His zeal for original thought proved singularly infectious and one by one the students who came under his influence kept crashing through the old wildernesses to settle and pioneer in a new land. As for Müller, we shall leave him engaged in a study of cartilaginous tissues and the minute structure of human glands. For it was in his effort to group connecting or connection tissues that Müller opened the doorway for the cell discoveries that were to follow.

Now, long before the cells were seen and understood in their proper relationships to the human machine, Malpighi had noted cells in the blood and a number of botanists had announced the cell structure in plants. Nearly two hundred years earlier, Robert Hooke, a botanist, used the word "cell" for the first time in discussing vegetable structure, and the presence of a cell nucleus in plants was discovered by Robert Brown, while studying the processes of generation in plants by means of pollen distribution. The full significance of the nucleus, however, was not realized until Matthias Schleiden, of Jena, began the transfer of this secret from the vegetable to the animal kingdom. Schleiden had started out to be a lawyer, but found in botany a hobby that took him away from the law courts. The microscope was still a most alluring toy for the curious, the inquisitive and for those scientifically inclined. Schleiden, while turning the lens on all forms of plant life, observed that plant tissues were made up of groups of cells, each of which

had a basic nucleus. He was mistaken, however, in his ideas concerning the method of cell production. He knew nothing of cell division and redivision, presuming cells to be created by some internal reformation. Here, once more, we come upon the importance of the seemingly trivial. Schleiden, as you have noticed, was a lawyer. The bent for controversy in the lawyer is traditional and this man was no exception. He dearly loved an argument that would give him an opportunity to use his legal training as a means of tripping his opponent. One evening, after dinner, with a group of scientific friends, he encountered Theodor Schwann, a young German recently arrived from Düsseldorf. Schwann, having shown an interest in the cell theory, was considered easy prey by Schleiden, who began a verbal tilt on the question. Schwann had but recently been a pupil of Johannes Müller, and had been taught the presence of cell nuclei in animal tissues. It needed merely the stimulus of such tantalizing arguments as those projected by Schleiden to provide a new impetus for young Schwann. He rushed away from the dinner table to his laboratory, there to begin thorough microscope investigation of all the tissues he could find. He took them from every portion of the human body, and after many a day of effort he came out with his historic announcement: "There is one universal principle of development for the elementary parts of organism, however different, and that principle is the formation of cells."

Many years later we are given a portrait of a jolly, modest, unpretentious little man, whose genial countenance drew about him an assemblage of friends, sitting in the cafés of Louvain, drinking his steins of dark beer and talking endlessly on cells and the germ theory of disease which, as Professor Ray Lankester has recorded, "was a pleasure no less startling than that which could be conferred by one suddenly risen from the dead."

In the years between, Schwann had made for himself an immortal place in the world of science.

Schwann, like Müller, had come from a family that admitted more than a speaking acquaintance with adversity. There were twelve other children and, as is often the case with large families, he was lost in the shuffle. Each child came to lean upon the one just ahead of him in years. It was the good fortune of Theodor to have his youthful steps guided by a brother who was a skilled

metal worker and mechanic. The lessons in craftsmanship thus learned stood Schwann in good stead in later years when, faced by a dearth of proper laboratorial equipment, he was able to fashion his own mechanical appliances and thus keep several leaps ahead of his fellows. In those days the successful culmination of many an effort depended as much upon the ability of the researcher to create his necessary apparatus as upon his mental equipment.

It was because of this early contact with the pressure of necessity that Schwann learned to struggle for whatever he went after. And it was because he was struggling for a Berlin professorship, carrying with it a salary of something like $7.50 a month, that the vast world of cells opened and man came one step closer to understanding the body he carries from cradle to grave.

It happened in this manner: After graduating from Bonn, Schwann had written a thesis with which he hoped to get a doctorate at the University of Berlin. His paper concerned the time at which oxygen reaches the embryo of a chick. Scientists had been haggling over this for some time. They had agreed upon the presence of an air chamber within the shell, but they were puzzled as to the exact period at which air becomes necessary for the survival of the organism.

Schwann had tackled his problem with his usual thoroughness. He had exposed a number of eggs to various gases; he had placed others in vacuums and found that, in the absence of air, development continued for a certain length of time and then all growth stopped. Restoration to air resulted in signs of renewed life; after a given length of time away from the air, he found there was no chance of revival. So far as this particular problem was concerned, he had solved it. But, in the course of his work, he had come upon something unexpected. He had taken the embryo itself and put it beneath the lens of a microscope. It was made up of a mass of tiny cells! He had found instances of other cellular groups in living tissue. But there it might have ended, so far as he was concerned, had not the lawyer-botanist, Schleiden, chanced to rouse Schwann to renewed efforts with his challenging arguments. So, it came about, Schwann succeeded in his revolutionary task of resolving all tissue to cell groups.

And what an exciting adventure this must have been! Even as

Leeuwenhoek had gazed on a new microbic world through his lenses, so Schwann had reduced life substance to its least common denominator. One gathers that enthusiasm ran high and that no day of his life was free from the peculations and speculations of his credulous or incredulous colleagues.

"Any day a bit of animal tissue, shaved off, picked to pieces with needles, or torn off with finger nails, might lead to ground-breaking discoveries," wrote a contemporary of Schwann. "Those were, indeed, great times! The mechanics of making the microscope had been sufficiently simplified, and the cost was no longer prohibitive"; the student of more limited means could own one or borrow one, and it was as necessary to research as the eye is to vision.

Schwann's efforts, however, did not end with the cell discovery. These new and minute worlds that he saw under the microscope led him to seek into other phases of life. Thus he found putrefaction to be produced by minute living bodies which can be destroyed by heat. He learned the eternal recreative processes which yeast can bring about. He discovered pepsin, proving its power to change albumin into peptones and showed the part played by bile and indigestion.

Another of Müller's students making history at almost the same time was Jakob Henle, a young man of Jewish extraction from Nuremberg, who became known as one of the world's greatest anatomists. It was Henle who, in his "handbook of pathology," sounded the warning which is to-day the motto of the medical world, "that prevention should be given a place of even greater importance than cure." Many were his investigations into the microscopic structure of organs and tissues and his elucidations of their functions. But the roster of names is too enormous to pause over each individual, and our story marches with such astonishing speed and is so replete with new discovery that only the peaks may be noted at this time.

The Cell had become the unit of life. It had become the very hub of the sentient universe. Man, made in the image of his Maker, was, in the first and last analysis, a product that grew from a single cell, and his entire body from the frail tissues of his brain to the hard enamel of his teeth was physically constructed of billions of differentiated cells. All life depended upon the life of the cell

and health depended upon its integrity and its harmonious association with other cells. The unit of existence having been discovered, it was only natural that in the structural changes of the cell man would find all expressions of disease and perhaps a way to conquer them. So it came about that while Schwann and Schleiden and thousands of other zealous students were seeking to unravel the innumerable problems presented by these tiny universes of which the body was made, there towered among them a small-statured, dynamic, meticulously thoroughgoing young Prussian by the name of Rudolf Virchow, who has already been mentioned as a pupil of Müller. Whether or not he was inspired by Leonardo da Vinci, he was building his life along lines that almost matched the versatility of Italy's great genius.

Virchow was at once a slave to his microscope and a servant to his government. One hour of the day found him in the Reichstag at war against the prejudices and caprices of injustice, railing at the demagogues in politics, and the next found him in his laboratory, where he was preparing strips of human tissue to learn the effects of all known disease upon the human cell. From a political battle in which he would be branded as a hot-headed radical, he would rush to the laboratory where the most conservative problems would demand his most painfully accurate attention. And so Virchow left his imprint upon history as a great statesman and as a supremely great scientist. Occasionally the language of one colored the thoughts of the other and in his vastly important work called "Cellular Pathology," he wrote, "The body is a state of cells in which each individual cell is a citizen. When forces internal or external bring a conflict among the citizens, disease is the result."

Virchow was born in 1821, and died in 1902. His early education was the best that the times provided. He received his inspiration for work from Johannes Müller and his scope of learning embraced practically every science that came within the compass of human knowledge. He was the first great pathologist. At the age of twenty-six he established the "Archives for Pathological Anatomy," a periodical concerned with the study of tissues in disease, which for half a century brought forth the best articles in medical advance. In the first number, he asserted a scientific truism

that an "unproved hypothesis in medicine is useless as a foundation for any doctrine." Another famous dictum that every cell must come from another threw the first light upon the elucidation of cancer and showed it to be a cellular structure depending upon some primitive cellular abnormality. No amount of space can adequately describe the impetus that Virchow's indefatigable effort gave to the knowledge of disease. He linked life and death by an explanatory network. He was not only a physician, but a pathologist, an anatomist, an epidemiologist, a sanitarian, a biologist, an anthropologist, and an archæologist as well. He not only did, but he taught, and he edited. And after he had made timeless contributions for the welfare of the sick man, he turned his attention to the man who was poorly governed, and in 1862 he joined the Prussian lower house and from 1880 until 1893 served the Reichstag as representative of the rights of the people.

During the Franco-Prussian War, he organized the Prussian Ambulance Corps and superintended the erection of the army hospital on the Tempelhof. The perfect sewage system of Berlin was largely a result of his efforts.

In 1899 he dedicated the Pathological Museum, to which he gave his private collection of over 23,000 specimens and preparations, each of which had been prepared, classified and labeled by his own hands.

In his spare time he was tracking the march of progress of antediluvian man, studying primitive skulls or interesting himself in the ruins of Egypt, Troy and Mycenæ, reshaping from the fragments and relics of bygone days the pages of unwritten history. Or else he was upsetting the naval program of Germany, matching his wits with or against the Iron Chancellor.

Sent by his government to investigate a typhus outbreak in upper Silesia, he came back with such tragic tales of the conditions among the workers that he inspired Hauptmann to write "The Weavers."

Just as in the late war the German was labeled "the Hun," so in the Franco-Prussian War was he called "a Mongol." This insinuation, born of war hatreds, Virchow could not disdain, and instead of letting the statement pass as an idle vituperation of an enemy, he organized six million Prussian school children and, mak-

PROFESSOR VIRCHOW

ing a complete census of their ancestry, used his report to refute the French charge.

Back from the affairs of state, where the boldness of his speeches made him unpopular in a conservative government, Virchow went to his laboratory and controlled probably the chief clinic in Europe. When past seventy, he still possessed an elastic figure, clear black eyes, and with unsparing energy he walked in professional dignity among his students, peering from microscope into microscope and explaining the innumerable variations that the ills of flesh imprint upon the cells of which it is made.

A hundred printed pages are needed just to note the titles of his scientific works, and even at eighty he was delivering two-hour lectures to his classes. He died as a result of a fall out of a car, but not until he had established the great Municipal Hospital in Berlin, which is now called by his name.

And so in a great paradox, beginning with Death and ending with Life, Science cracks its shell.

There are many living to-day who knew Virchow, saw him, talked with him and received the benefits of the inspiration of his personality. Strange it is that our forefathers lived and multiplied and survived in complete ignorance of scientific truth. Yet we have said in the beginning of our story that life will find the way, and we here add that the way was a short one compared with the expectancy of life, health, and happiness to-day.

Science has cracked its shell and its development has been prodigious. Every day in every way new truths are being unearthed, new facts discovered and the "grim angel" finds his path beset by the concerted effort of the scientific world so that man's sojourn may be long before he attains "the undiscovered country from whose bourn no traveler returns."

CHAPTER XII

A Scratch in Time

One of the most wickedly romantic characters in history, as yet unpopularized by film and syndication, was Mithridates, King of Pontus, who held sway one hundred years before Christ.

Intrigue, conspiracy and a very trivial respect for human life were so much a part of his daily fare that he himself walked constantly in the shadow of the fear of swift or insidious dispatch. He carried pellets of death in his purse, as a schoolboy carries marbles and those about him never knew whether his invitation to dinner presaged an attack of indigestion or cured it forever. So Mithridates began to eat tiny quantities of every known poison, hoping thereby to develop a gradual immunity to a larger dose which some smiling sycophant might have given him just by way of having a little fun. The important thing is that the ancients knew the doctrine of the ounce of prevention. They had learned that gradual inurement to what would ordinarily be considered a fatal issue thwarted its usual effect. That if you saw a little of the devil at a time the entire monster lost his aspect of terror.

Probably long before this time man noticed that certain diseases occur only once in a lifetime, so that after recovery from such a disease he was immune against further attacks. The earliest attempt to utilize this protective act of Nature prompted parents to expose their children to a disease such as measles, when it occurred in a mild form, in order to protect them against more virulent types that the future might bring. It is recorded that this vague perception of the principles of immunity existed at a very early period. Tradition has it that a thousand years before Christ, in India and China, children were inoculated with the noxious matter of smallpox in order to forestall the dread disease. Among savage tribes of aboriginal Africa, early explorers had noticed that the natives practiced a form of inoculation against the bites of poisonous

snakes. They mixed the venom of the serpents with vegetable juices and rubbed them into an incision in the skin. There were local effects of pain and swelling, but they established an immunity to the venom of the hidden enemies of the bush.

Bruce, in his "Voyage to the Sources of the Nile," published in 1790, states that a form of inoculation against smallpox had been practiced by the negro races in Nubia since time immemorial, and that the practice had spread to all the neighboring tribes. The operation was called "buying smallpox." The method was by contact. A woman took a piece of cotton impregnated with the virus of smallpox and applied it to the arms of her children.

Long before the white man's influences of civilization had penetrated the abodes of the savage, his experience had taught him the value of inoculation against smallpox and venereal diseases, and it is stated that even in darkest Africa healthy animals were inoculated with the pus of others who had died of epidemic diseases. According to Colonel King, an English Army Surgeon, Dhanvantari, the Vedic Father of Medicine, the earliest known Hindu physician, who was supposed to have lived about fifteen hundred years before Christ, is said to have practiced inoculation for smallpox and to have employed a vaccine which had been prepared by transmission of the virus through the medium of a cow.

No authenticated records exist of the history of smallpox in China, but the most reliable evidence of the antiquity of the practice of inoculation is given by Francis Xavier D'Entercolle, a Jesuit missionary in the eighteenth century, who quotes an extract from the work of a Chinese physician of the Ming dynasty, mentioning the practice, but saying that since every one must necessarily have smallpox once in his life, it was better to let it be contracted naturally. Nevertheless, the priest further states that the Emperor of China sent a number of physicians in 1724 from Peking to Tartary, where the inhabitants were suffering from an epidemic of smallpox, in order to inoculate the children against the disease. That the operations that they performed were successful was evidenced by the fact that the physicians returned laden with presents of horses, skins, etc., presented to them by the Tartars in payment for their services.

Many explorers have noted that in the most remote corners of the

earth inoculation against smallpox had been a common custom, but that the method was crude and its origin a matter of tradition.

The time of the first actual outbreak of smallpox in Europe was probably about the latter part of the sixth century. It appears to have traveled west from Arabia, Ethiopia and the neighboring countries, and was brought by the Arabs into Egypt. It was apparently unknown to the Greeks and Romans and, according to ancient histories, does not appear before this time to have attacked civilized nations engaged in commerce or war in foreign countries.

The earliest definite statement concerning the disease came from Arabia, dated 572 A.D., the year of Mahomet's birth.

Certain passages in the chronicle of Bishop Marius, who died 590 A.D., tend to corroborate the Arab manuscript. "A powerful scourge, with flow from the abdomen and pox, spread extensively over Italy and France, and in 571 killed innumerable people in the above-mentioned countries."

That smallpox must have been one of the most baneful scourges of ancient and medieval times is evidenced by the fact that, of all diseases, it is best described in old medical literature. Its name is derived from an Anglo-Saxon word meaning a spot or speck. Both Greek and Latin have names for it. The books on physics written in Arabia, from the seventh century on, have all contained more or less exhaustive accounts of the disease and methods of treatment. In England it is first mentioned in an Anglo-Saxon manuscript of the tenth century. Sydenham was the first classically to describe the disease and differentiate it from other eruptive fevers.

The knowledge of the practice of inoculation against smallpox was fairly well distributed through Europe in the seventeenth and eighteenth centuries. It had not achieved the sanction of the medical fraternity and was not necessarily carried out by doctors. Among the people, however, it was practiced in almost every country and in Denmark, in 1758, two inoculation houses were established by the King, and one of the Royal Princes was successfully inoculated. The methods varied with communities and their traditions, but all of them consisted of the transference of the contents of a pustule to the abraded skin of the person to be immunized. Even as the practice of vaccination has its antagonists to-day, so in the eighteenth century, a serious and fatal outbreak of smallpox in Paris was

attributed to inoculation, with the result that the practice was prohibited by the government; but within five years they realized their error and rescinded the decree.

A curious sidelight, which shows how the burning questions of the time are reflected even in the fashions of the day, is related in the life of the famous Mlle. Rose Bertin, who was milliner to Marie Antoinette. Mlle. Bertin owed her European reputation to her taste and the ingenuity with which she utilized current events to vary her fashionable designs. In the latter part of the eighteenth century, the elaborate coiffures affected by ladies of the period were of the most extraordinary description. One of these, known as the "pouf a l'Inoculation," was introduced by Mlle. Rose Bertin to coincide with the inoculation of the young king, Louis XVI, which took place on June 18, 1774. For some time after this interesting event, every lady who wished to be in the fashion wore in her hair a miniature model of the rising sun and a heavily laden olive tree, round whose trunk was entwined a serpent, supporting a club, wreathed with flowers. This device was supposed to symbolize the power of medicine, represented by the snake, to overcome the horrors of smallpox; the rising sun was supposed to symbolize the royal patient, who was a descendant of "le roi soleil," while the olive tree represented the peace and joy of his loving subjects at the successful issue of the operation.

It is interesting to note that in Circassia, where the beauty of the women frequently sold them into amatory slavery, inoculation was compulsory, for those whose features were marred by the scars of smallpox brought a low price in the market.

The enthusiastic interest taken in behalf of inoculation against the ravages of this disease reached its climax when the Empress Catherine the Second of Russia summoned Dr. Dimsdale, a London specialist, to introduce the practice into her country. Her Imperial Majesty, herself, submitted to the operation and her example was emulated by the Grand Duke and many of her retinue. So successful was Dr. Dimsdale that he was made a Baron of the Russian Empire, receiving an award of a thousand pounds in addition to an annuity of five hundred. This will not seem extravagant when it is remembered that the mortality from smallpox in Europe at the end of the eighteenth century was two hundred and ten per

thousand and reached even higher figures during epidemics. In Russia, in one year, no fewer than two million people perished from the disease.

Lady Mary Wortley Montagu, the wife of the British Ambassador to Turkey, is responsible for the first creditable record of the introduction of inoculation against smallpox into England. She had observed the benign effects of inoculation in the Ottoman empire, and perhaps one may best refer to the history of the time by quoting her letter to a friend in London, Miss Sarah Chiswell. She wrote as follows: "Apropos of distempers, I am going to tell you a thing that I am sure will make you wish yourself here. The smallpox, so fatal and so general amongst us, is here entirely harmless by the invention of ingrafting, which is the term they give it. There is a set of old women who make it their business to perform the operation every autumn, in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the smallpox. They make parties for this purpose, and when they are met (commonly fifteen or sixteen together), the old woman comes with a nutshell full of the matter of the best sort of smallpox and asks what veins you please to have opened. She immediately rips open that you offer to her with a large needle (which gives you no more pain than a common scratch), and puts into the vein as much venom as can lie upon the head of her needle, and after binds up the little wound with a hollow bit of shell; and in this manner opens four or five veins. The Grecians have commonly the superstition of opening one in the middle of the forehead, in each arm, and on the breast, to mark the sign of the cross; but this has a very ill effect, all these wounds leaving little scars, and is not done by those that are not superstitious, who choose to have them in the legs, or that part of the arm that is concealed. The children or young patients play together all the rest of the day, and are in perfect health to the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have very rarely above twenty or thirty in their faces, which never mark; and in eight days' time they are as well as before their illness. Where they are wounded, there remain running sores during the distemper, which I don't doubt is a great relief to it. Every year thousands undergo

this operation; and the French Ambassador says pleasantly that they take the smallpox here by way of diversion, as they take the waters in other countries. There is no example of any one that has died in it, and you may believe I am very well satisfied of the safety of the experiment, since I intend to try it on my dear little son. I am patriot enough to take pains to bring this useful invention into fashion in England; and I should not fail to write to some of our doctors very particularly about it, if I knew any one of them that I thought had virtue enough to destroy such a considerable branch of their revenue for the good of mankind. But that distemper is too beneficial to them not to expose to all their resentment, the hardy wight that should undertake to put an end to it. Perhaps if I live to return, I may, however, have courage to war with them. Upon this occasion admire the heroism in the heart of your friend."

Lady Mary then pursued a vigorous crusade for inoculation. Her own children were submitted to the operation with excellent results. Experiments were made on criminals, who were promised pardon if they submitted. Then the method was introduced in the orphanages and eventually the royal children themselves were inoculated. Heated controversies developed on all sides. A hue and cry arose between the protagonists and the antagonists of the procedure. The clergy, who were then intimately concerned with the bedside, repudiated the scientific interference with the domain of their influence and stigmatized inoculation as an outgrowth of quackery, atheism and avarice. Yet, in spite of the fact that many people regarded inoculation with fear and suspicion, more and more were submitting to the practice.

The patients were put into the best possible condition of health by diet, bathing and tonic treatment and all the hygienic principles available were used to foster a mild form of the disease.

The difference between smallpox by contagion and smallpox by inoculation is simply this: In contagion, the virus probably enters the blood through the respiratory passages and a true infection of the blood takes place before the symptoms of the disease manifest themselves. In inoculation, the blood has more time in which to develop the immune substances that fight the poison of smallpox. The resistance of the patient thereby is increased and the disease pursues a milder course.

The story of health has been a constant battle between the old and the new. Tradition has ever been the foster-mother to science, and once again she unfolded a new vision to its eager eye.

Over an unknown period, milkmaids and farm hands had known of a disease among cattle which they called cowpox and which they were liable to contract from the animals. During the reign of Charles II, the court ladies looked with envy upon the dairymaids because their complexions were so rarely marked by the scars of smallpox. In Ireland, where superstition has ever been twin sister of fact, old women had been whispering that "those who got cowpox, never got smallpox." There is an interesting note left by Mr. Nash, an English medical practitioner, who died in 1785, which reads as follows: "I never heard of one having the smallpox who ever had the cowpox. The cowpox certainly prevents a person from having the smallpox. I have now inoculated about sixty persons, who have been reported to have had the cowpox, and I believe at least forty of them I could not infect with the variolous virus. The other twenty, or nearly that number, I think it is very reasonable to presume (as they were no judges), had not the real cowpox. It is not my own opinion only, but that of several other medical gentlemen, that convinces me the cowpox is a prophylactick for the smallpox. My principal intention in publishing being to recommend to the world a method of inoculation that is far superior in my opinion (and I judge it from experience) to any yet made known; therefore I hope and trust, although I have no medical friend to enforce it upon the world, that they will give me so far credit for my assertions as to make the experiment, and then it will sufficiently introduce itself."

The most significant incident, however, in the history of cowpox inoculation is that of Benjamin Jesty, a farmer in Dorset. In 1774, he inoculated his wife and two of his children with cowpox matter in view of the fact that a particularly virulent epidemic of smallpox was raging at the time. The boldness and novelty of his experiment created quite a sensation in the neighborhood, largely due to the fact that Mrs. Jesty's arm became considerably inflamed. He came upon the idea because two of his servants, who had had cowpox, had nursed cases of smallpox without acquiring the disease. This was the first recorded intentional inoculation with cowpox and the

tombstone over the grave of Benjamin Jesty bears the following inscription:

Sacred
To the Memory
of
Benj. Jesty (of Downshay)
Who departed this life
April 16th, 1816
Aged 79 years

He was born at Yetminster in this County, and was an upright Honest man; particularly noted for having been the first Person (known) that introduced the Cow Pox by inoculation, and who, from his great strength of mind, made the experiment from the Cow on his wife and two sons in the year 1774.

His wife lived to be eighty-four and was buried by his side.

The close of the eighteenth century is witness to the dawn of a new era in preventive medicine. The scratch in time was advocated and established by Edward Jenner, an English physician whose name will ever be immortalized as the vanquisher of smallpox, probably the greatest scourge that ever threatened human existence. With death and deformity in its wake, smallpox had swept the civilized world from time to time with such devastating breath that we, who are fortunately immune from it, cannot quite conceive the violence of its terror. No life was certain before its advance and it spread with the winds from the remote corners of the earth, taking with impartial vengeance, infant and dotard, rich and poor, scholar and imbecile.

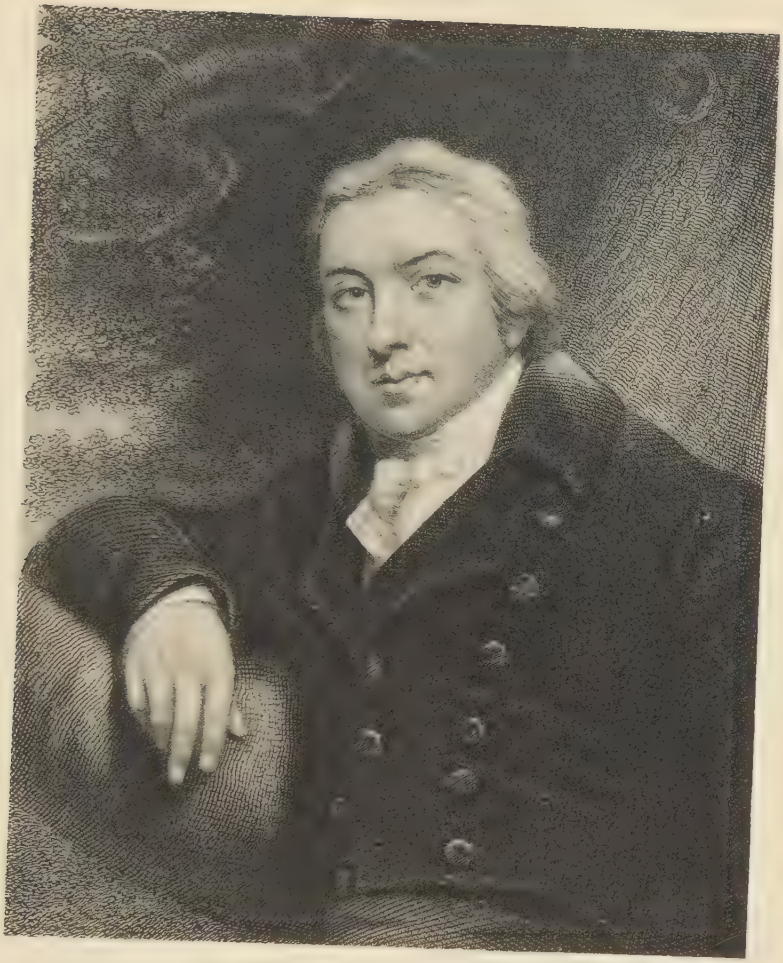
Jenner was born in 1749 at Berkeley, in Gloucestershire. When he was eight years old, his parents decided that he should be inoculated against smallpox, and he was put under a preparatory regimen. "For six weeks," states Jenner, "he was bled and purged and kept on a low diet, and dosed with medicine and then removed to one of the so-called inoculation stables and haltered up with others in a terrible state of disease." He was fortunate to escape with a mild attack but the experience that he went through made such an im-

pression upon his mind that he determined to make the conquest of the disease the problem of his life. At the age of thirteen, he decided to follow the profession of medicine and was apprenticed to a firm of surgeons in Sudbury where he remained for six years. During this apprenticeship, he met a young woman, who, during her conversation, exclaimed, "I cannot take smallpox, for I have had cowpox." The impression that this statement made upon Jenner's mind was indelible.

On attaining his majority, Jenner came to London and became a house pupil of the famous John Hunter. He frequently discussed with Hunter his hopes and fears relating to the possibility of substituting vaccination for inoculation. Hunter's characteristic reply was, "Don't think, Jenner, try!"

Returning to Berkeley to practice medicine, he had the misfortune to fall in love and wrote John Hunter that his wooing did not prosper. Hunter wrote him, "Never mind the woman, I shall employ you with hedgehogs," and outlined several scientific experiments for Jenner to pursue to assuage his amatory disappointment. Jenner then began an intensive study of cowpox as it appeared in animals. Walking one day with a friend, he mentioned his idea and his hope of being able to propagate a variety of cowpox from one human to another until he had disseminated the practice all over the globe to the total extinction of the dread smallpox. He further said, "I have entrusted an important matter to you and should not wish to have it brought into conversation for, should anything untoward turn up in my experiments, I should be made, particularly by my medical brethren, the subject of ridicule."

Jenner progressed slowly until he was convinced that cowpox, as seen in the animals in the farmyard, was a very mild form of smallpox and would undoubtedly confer immunity against its malignancy. So surely was he convinced, and such is the courage of the true scientist, that in November, 1789, he vaccinated his only son, Edward, who was then about eighteen months old, with the purulent contents of a swinepox pustule. It takes few words to describe the experiment, but it will make your own heart skip a beat to think of a father submitting his only child to disfigurement and possible death in order to protect humanity, and save it from the most treacherous pestilence of civilization. Two years later, he reinoculated the



EDWARD JENNER

boy, on April 7, 1791, and the child showed absolutely no sign of indisposition. He was immune.

Just as Alexis St. Martin was catapulted to scientific fame by having a piece of his abdominal wall blown away, exposing his stomach, so does the name of Sarah Neames, a dairymaid of Gloucestershire, adorn for a moment the pages of the history of science. Sarah got the cowpox at the right time. Jenner seized the opportunity to put his theories to a practical test. He took some matter from a sore on the maid's hand and inserted it through superficial incisions into the arms of James Phipps, a healthy youngster about eight years old. The vaccination was successful. The boy developed lesions similar to those of cowpox, first a sore, then a vesicle, then a pustule, finally a scab and a scar. He suffered no ill effects at all. After a period of six weeks, Jenner inoculated young Phipps with lymph of a case of smallpox and, to his great delight, no smallpox ensued. Jenner repeated his experiment several times and, in June, 1798, published his historic paper in the Transactions of the Royal Society.

Vaccination was discovered or rediscovered. The farmyard animal, that the primordial man had tamed to give him milk and meat and to share his burdens in the fields, had now given him a remedy against a frightful disease and it caused the story of health to take a tremendous bound forward to new concepts, new vistas, and new accomplishments.

Vaccination spread like wildfire over the civilized world, but not without the antagonism of those who "are the *last* to bring the new in tide." After Jenner was presented to the King and Queen, whose encouragement and material aid helped him spread the propaganda of vaccination, it was taken up in America and, as early as 1797, a Dr. Waterhouse of Massachusetts advocated its universal application. Thomas Jefferson had the members of his own family vaccinated and practically all who submitted found themselves immune to smallpox. The propaganda then spread over the Continent and was taken up with enthusiasm in France, Germany, Austria, Italy, Spain and Switzerland. In countries where smallpox was particularly rife, religious processions were formed for receiving the "blessed vaccination." Twenty thousand people were vaccinated in a few years in the city of Milan. Napoleon manifested his confi-

dence in Jenner's theories by ordering all his soldiers, who had not suffered from smallpox, to be vaccinated. So great an impression had been made upon the Empress of Russia that she urged all her subjects to be vaccinated, ordered that the first child submitted to the operation should be called "Vaccinoff" and be educated at public expense. The young Vaccinoff, after vaccination, was taken to St. Petersburg in one of her Majesty's Imperial coaches and after being educated in the Foundling Hospital received a pension for life.

Jenner's influence and glory increased in leaps and bounds. A story is told of a Dr. Wickham who was a Napoleonic prisoner of war. Several of his friends persuaded Jenner to present a petition for his release to Napoleon. When the petition was forwarded, Napoleon happened to be seated in his carriage together with the Empress Josephine. Glancing at it, he exclaimed to the driver, "Away, away!" But the Empress, examining the paper, said, "But you see from whom this comes, Jenner." Napoleon changed his manner immediately and replied, "What that man asks for, is not to be refused." And so Wickham was released.

We know very well to-day that vaccinations "took" and occasionally did not "take," and that at times it requires repeated inoculations to get a positive, or "taking," reaction. We furthermore know that the immunity attained lasts only a certain period of time and we revaccinate our children in order to be certain of its steadfastness. We also know that vaccinated people occasionally are infected with smallpox, although the disease usually runs a mild course. These freaks of biological perversion are the exceptions proving the almost infallible rule that cowpox does prevent, and has almost eliminated, smallpox from civilized countries. In Jenner's day, successive failures of inoculation, possibly due to an impotent lymph, put many doubts and difficulties into his pathway.

There were many who still opposed the practice most vigorously and many diatribes were published, venomous in their expression, against the so-called pernicious practice. Caricatures filled the papers, for the subject fed the pen of the lampoonist and comic artist with fertile material. Where secondary infection entered the site of inoculation, and produced undue swelling of the arm, cowpox was blamed. Bigotry and intolerance, ever treading upon the hem

of truth, did everything to hamper its progress. The pulpit in certain instances emphasized the vituperation. One divine is quoted as saying, "Smallpox is a visitation from God, but cowpox is produced by presumptuous man. The former is what Heaven ordained, the latter is a violation of our holy religion." The reaction is not without parallel in our own day. We have it on good authority that when Oom Paul Kruger was president of the Transvaal, the country was swept by clouds of locusts that descended upon the crops and destroyed them with ravenous malice. The farmers built little trenches in the fields which they filled with oil and ignited to destroy the swarming pests. President Kruger, having reached the time of life when he considered it expedient to be on good terms with his Maker, passed a law forbidding the burning of the locusts, saying they were a visitation from God and therefore should be allowed to survive.

Stories were told that, since vaccination, one girl mooed like a cow and had hair all over her body, and in another instance that a boy bellowed like a bull.

Here was, perhaps, the greatest panacea ever given to man by a Divine Providence through the instrument of one of its humble servants, called by its own interpreters "the damnest thing ever proposed" and "the most degrading relapse of civilization that ever disgraced the civilized world."

Yet, notwithstanding all this, Jenner worked like a slave. The poor were treated without compensation and Jenner himself vaccinated as many as three hundred a day.

Honors were conferred upon him from every part of the grateful globe. Perhaps one that pleased him most was the quaintly worded appreciation sent him by the Red Indians of North America:

"Brother! Our Father has delivered to us the book you sent to instruct us how to use the discovery which the Great Spirit made to you, whereby the smallpox, that fatal enemy of our tribe, may be driven from the earth. We have deposited your book in the hands of a man of skill whom our Great Father employs to attend us when sick or wounded. We shall not fail to teach our children to speak the name of Jenner and to thank the Great Spirit for the bestowing upon him so much wisdom and so much benevolence. We send with this a belt and string of wampum in token of our

acceptance of your precious gift, and we beseech the Great Spirit to take care of you in this world, and in the land of spirits."

A great deal more can be said about the personality of Edward Jenner. He was a picturesque figure, lived life dynamically and humanly. When he was sixty years old, he lost his son whom he loved devotedly. The following year, his sister died and soon after his wife was taken away from him. Torn with grief, he retired to Berkeley and was stricken with an attack of apoplexy from which he never rallied. He died on the 26th of January, 1823.

The most eloquent tributes to his memory are the lives that his monumental discovery has been instrumental in saving, and the principles that he advocated shall ever add luster to his name as a successful pioneer in the field of protective inoculation against disease, and as one of humanity's greatest benefactors.

The results of vaccination stimulated the medical Alexanders to look for new worlds to conquer. And, strange as it may seem, the first conquest must be credited to the farmyard rather than to the laboratory. The peasant countries of Europe depended then, as now, upon their live stock and their agriculture. Without healthy cattle and healthy crops there could not be healthy humans. If the cattle died or the crops failed, the peasant starved. At the time that this particular phase of the story of health opens, Anthrax was the mysterious enemy destroying thousands upon thousands of the animals, upon which his very subsistence depended, and spreading despair over the countryside.

Here let us "cut back," as they say in the films, and refresh our memories as to the progress of events. We recall Leeuwenhoek sitting over his microscope in his little store and wondering about the tiny wriggling creatures that he saw beneath the lens. Before he died, he asserted that these tiny things had life. Then came Spallanzani to show that they were not sudden appearances of the simplest forms of life, coming from nowhere, but had a definite germinating process; that one produced another in endless multiplication unless they were killed. So small were these creatures that the average thought of the day dismissed them with unconcern and deemed them unworthy of consideration. It took a long time for men to realize that the longest line was only a succession of points, that the highest mountain was made of grains of sand, that the ocean

represented merely an infinite number of drops of water, that the human body was formed by the growth of cell upon cell and that disease and death were produced by the multiplication of these microscopic forms of life when their number and their virulence exceeded Nature's capacity for destroying them.

Anthrax was the first disease that definitely established a germ or bacteria as its cause. Dr. De La Fonde, a French veterinary surgeon, examined the blood of infected cattle and noted little rods swimming about. The German, Henle, concluded that these were living organisms and another Frenchman, Davaine, went as far as to say that he was certain that the anthrax bacilli were organisms endowed with life, developed and propagated in the same way as other living entities. He commented upon their rapid multiplication and noted their reproduction resembled the process seen in fermentation.

The name of Pasteur—Louis Pasteur—has become an epic in the annals of biology. He is the Mt. Everest that shall forever dominate the highest place in the panorama of science. Pasteur applied the seven-league boots with which the story of health was able to advance from the floating island of conjecture to the limitless continent of Fact. The foundation of all the knowledge we possess of infection—acute or chronic—was laid by him. Wherever a specific organism has been discovered or suspected, its isolation and conquest are recurrent tributes to this eccentric genius. To portray him with justice to his personality, one would need a very wide canvas and limitless colors. Occasionally he was arrogant and indulged in unbecoming braggadocio. But we can understand his quixotic enthusiasm when we consider a Latin temperament soaring on wings of fantasy, check-reined by the stern and sturdy hand of science. Strange and new were the vistas of enlightenment that swept into his ken and he knew that he was the first to trespass upon untrodden paths of truth. On the other hand, we find him a self-effacing, modest and most diligent investigator, with the intuition of a great genius, fortunately exerting his efforts in a domain where he could be of the utmost benefit to his fellow men. Pasteur was trained as a chemist and came nearer than any one else to explaining the all-important phenomena in the mystery of life and growth and death.

Man cannot live without food, and of all forms of sustenance milk is the most essential. But the milk of contented cows, like the milk of human kindness, was quickly soured when exposed to unfriendly elements. Pasteur discovered that this process of the souring of milk was dependent upon a living organism. And he further discovered that the change from starch to alcohol, from the staff of life to the cup that cheers, was produced by living, budding cells; in short, he discovered the secret of bacterial life and fermentation. The importance of this discovery and its application to the industry of distilling, made France the first of the wine-producing nations of the world.

In another district of France, silkworms were dying and the industry was threatened with extinction. Looking for a cause, Pasteur learned that certain tainted leaves upon which the worms fed caused their malady, and again found a microbic agency responsible for the epidemic. Here he conceived the idea of segregation, and in keeping the healthy worms away from the sick worms and from tainted leaves, he practically saved the entire industry for France. Pasteur foresaw the possible relationship of these germs to human disease. He was able to isolate them, grow them and kill them by heat and chemical agency. The term "to Pasteurize" means "to kill germs by a specific amount of heat." While Pasteur was thus engaged preserving the industries of France, meeting his realities through the vineyard and the mulberry-bush, a German by the name of Robert Koch was destined by Fate to approach the problem of disease, first in the farm and then at the bedside of stricken humans.

Such are the uncertain twists by which Fate manipulates events that Koch might have been almost anything in the world save a bacteriologist had it not been for a pretty girl and a birthday present. Koch fell in love with the girl, just about the time he had determined upon a life of adventure. She married him on condition that he settle down to a doctor's life. And, having done this, she gave him a microscope for his birthday. She felt that, since they had settled in a dreary countryside, he might regret having given up a romantic life unless he had something to occupy his attention. As a matter of fact, Koch was in a bad state of mind. A sensitive, imaginative man, he felt helpless as a child in the presence of most diseases. He complained of how little was known about disease and

its causes. He said that his hands were tied; that he was presumed to help humanity, when no one in all the world knew even the reason for an epidemic. In a sort of despair he approached a task, the outcome of which inspired him with little hope. Unlike the super-enthusiastic Pasteur, he regarded his microscope with a feeling of futility.

Then, across his stolid countryside, came the terror of anthrax, and rich and poor alike suffered and despaired while their cattle died and their purses wasted. Koch secured the blood of one dead animal and put it under the microscope. There, swimming among the cells, he saw minute rod-like strangers that normal blood did not reveal. Davaine and Rayer had also noted these tiny rods and thought them to be bacilli, but had proved nothing. Convinced now that the obscure threads were definitely in the picture, he determined to experiment with white mice. His poverty was such that he could not afford adequate equipment for his work. When he transplanted the little rods from dead animals to mice, he had to use bits of wood he had himself fashioned. The first mouse died; so did the second and the third—and when he cut open the little martyrs, he found that they had died as the sheep had died and that their blood contained the same little rods. He now became determined to see these tiny slayers in the process of growing and multiplying. He sought for food upon which the microbes might feed. With his oil lamp as a heater, he built a crude incubator. He used fluid from a slain ox's eye as a breeding ground. And then he watched—and watched! After several hours he saw in one tiny drop, a whole regiment of twisting little threads. With these he could reproduce the disease. His search had ended! He had found the why and the wherefore of anthrax! It was a rather startling and terrible picture that had flashed before him. It was one to change the entire outlook upon life and death and disease!

The overawing significance of Koch's discovery was simply this: An animal died of a disease. In the blood of the animal occurred a germ which caused the disease. The germ could be grown outside of the animal. When injected into another animal, it produced the same disease. The science of bacteriology was born! Pasteur had stated the theory; Koch had proven it. The approbation and dissension—the will to believe and the desire to destroy, that followed

Koch's announcement, produced raging and conflicting storms of opinion as had never before swept over the scientific world. Wherever there was a microscope and a man who could use it, there was either confirmation or contradiction and the fires of investigation were blazing in every recess of the civilized world. But it was Koch, the pioneer, and his assistants who were doing most to identify the varying bacteria that were responsible for disease. Propagating them on culture media congenial to their growth, segregating them, noting their characteristics, staining them, photographing them, he developed the science of bacteriology that he had discovered. Verifying Koch's work, Pasteur stated that earthworms, feeding on decomposed bodies of animals killed by the disease, carried the germs to uninfected animals.

Koch was immersed in the problem of tuberculosis, the germ of which he had discovered. Pasteur was asking himself another question. What good was it to know the cause of disease if you could not find a remedy? About this time a veterinarian, by the name of Louvrier, who lived in the Jura mountains, reported a cure for anthrax. Pasteur was sent to investigate it and found the veterinary incising the abscess and pouring in vinegar and turpentine. Pasteur had little faith in this remedy and conceived the notion that perhaps there were cows that recovered in spite of the treatment. He then took a number of cows that survived the disease and injected enormous doses of living germs into them. Still the animals survived. There was but one conclusion. Once an animal had anthrax and lived, it was immunized. Here, Jenner's work in smallpox flashed across his mind. He wondered if he could give healthy animals a mild case of the disease and thus save them.

At about the same time, another call from the countryside came to Pasteur. Chicken raisers reported a serious spread of chicken cholera among their broods and asked for Pasteur's help. Pasteur discovered the microörganism that was responsible for the disease, and found that he could reproduce the disease by reinoculation. But then he came upon a great new discovery. Microbes that had been allowed to grow for several days before being inoculated, somehow or other lost their virulence and produced only a mild attack of the disease from which the chickens recovered, and to which they remained immune. Would not the same be true of anthrax? He

rushed back to Paris and took sixty sheep. Half of these he injected with an attenuated anthrax culture. To the rest he gave a virulent one. The first half survived, the second died—even according to his prediction. So was the idea of an artificially established immunity by injections of small doses of attenuated germs confirmed. What had been done for cows and chickens must now be attempted for man.

What Mithridates had accomplished with drugs could be repeated with bacteria. It depended upon the scratch or stick in time.

Meanwhile, Pasteur and Koch were traveling parallel paths. Pasteur was having his troubles. Supremely confident of his methods, he was occasionally careless in performing the enormous amount of work thrust upon him. The virus that he had been turning out was not always uncontaminated, nor was it always perfectly prepared. Failure followed. And it was Koch who found that Pasteur's errors were not due to faulty thinking, but to improper preparation of his material. But Pasteur was off on another problem.

Throughout the ages, one of the most malicious and devastating scourges that afflicted man was caused by the bite of his most faithful friend—the dog. This was rabies or hydrophobia. Celsus, the medical historian of early Roman times, had described its dread symptomatology. From Galen's time, many methods had been used to avoid its inevitable catastrophe. Cauterization, excision, prayer, immersion—everything had failed. Hydrophobia was considered an absolutely incurable disease.

It was in 1880, shortly before his anthrax vaccine reached the peak of its popularity, that Pasteur became interested in rabies. He had been talking with an old veterinarian by the name of Bourrel on the subject of anthrax, when Bourrel made mention of the menace of mad dogs in his particular neighborhood. Since the scientific opinion of Pasteur had become unquestionable through the countryside, Bourrel naturally inquired what Pasteur thought of this malady. As a matter of fact, the chemist had not thought about it at all since his boyhood, when he had seen a mad dog bite a boy with whom he had been playing. The boy had been taken to a blacksmith shop and there seared with a hot iron in an effort to burn away the infection. Pasteur did not tell Bourrel that the disease was farthest from his thoughts, but the moment he returned to his laboratory, he

laid aside all other work and put his loyal aides to the investigation of the hydrophobia germ. Try as they would, they could find no sign of it. Yet, when they transferred bits of a dead animal into the brain of a live one, they saw the malady transferred. Again they would peer through their glasses, but could only conclude that it was too small for their eyes to see, and that it killed its victims by its toxic action on the brain and the spinal cord. Thanks to one of his assistants, Roux, Pasteur learned to trephine the skulls of his laboratorial menagerie and watched the progress of the disease through hundreds of cases. One day, opportunity for another phase of investigation was opened to him. He heard that a child had been brought to the Trousseau hospital for treatment. When he arrived, the child was dead, but he was able to get some of the mucous froth that had come from the unfortunate child's mouth. He injected some of it into several of his rabbits and found that they succumbed to the disease. He now knew the nature of the poison. He continued his experiments with feverish interest. Hearing from his old friend Bourrel that a mad dog had been menacing his kennels, Pasteur hurried over only to be faced with the problem of capturing the animal whose bite was to be avoided at any cost. Yet it must be captured alive. Finally a lasso was perfected, the dog was roped and tied, and Pasteur proved his heroism for all time. With a glass tube in his mouth, the scientist bent over the struggling, snarling dog, and with his own lips sucked small quantities of poisonous foam into it. The slightest slip might have meant self-inoculation.

Pasteur began his work on rabies antitoxin. Hundreds of animals were sacrificed on the altar of science. After working for four years, in 1885, he wrote to a friend: "I am demonstrating this year that dogs can be made immune to rabies. I have not yet dared to try human beings, but the time is not far off and I am inclined to begin with myself, inoculating myself with rabies and then arresting the disease, for I am beginning to feel very sure of my results."

The necessity for this attempted sacrifice never arose, for within two months of the time the letter was written, two physicians were at his door, beseeching him to make his test on a nine-year-old lad, Joseph Meister, whose mother had rushed him in from Alsace for treatment. Pasteur hesitated. Conflicting emotions battled within him. He needed time to decide. He advised the mother to return

later. The doctors pleaded with him that there was nothing to lose and everything to gain. The child was fated to die in the terrible convulsions that always accompany the disease. It was a crucial moment in Pasteur's life. He selected an emulsion of the virus that was two weeks old and sufficiently weakened, he hoped, to inoculate the boy without actually adding to the virulence of the disease. Pasteur had his ever faithful helpmeet prepare a room for the mother. The mother and child arrived. Pasteur kept the child amused playing with the rabbits. Then, late in the day the die was cast. For the first time a human being was injected with the virus of hydrophobia. There followed a terrible period of suspense. Other inoculations had to be made. For something like three weeks this had to go on! Each day the situation grew more tense and the scientist grew more restless. He could not sleep at night. He would awaken from his sleep, ridden by nightmares which revealed to him a child foaming at the mouth and clutching at the air. "All is well," he jotted down in a diary. "The child sleeps and has an appetite. If the lad but keeps well during the following weeks I think the experiments will be safely concluded."

After the last injection, Pasteur was in a state of collapse. Once before he had had a stroke of paralysis, and his patient and tender colleague feared another. He was induced to take a rest, leaving the boy in the hands of a physician. It was a restless vacation, interrupted with constant demands for reports. When Pasteur returned from his visit to the country, the boy was already back in Alsace, completely recovered. Three months later came the report that he continued in excellent health. Preventive treatment by inoculation had taken another step forward!

Reports of the miracle cure again brought the world to his gate. From every land came messages; physicians came from every place upon the map to study his method and victims of rabies flooded him with pleas for assistance. Out of Russia came a regiment of peasants, bitten by a mad wolf two weeks before their arrival in Paris—and he saved all but three! For this service a diamond emblem came from the Czar. Money poured in upon him for the establishment of a greater laboratory.

In the midst of the furor, there came another sinister sound from far away. Asiatic cholera was slaying thousands in India. It had

spread to Egypt. It might be carried to Europe. Pasteur had heard this cry before he had finished his work on rabies. It had also come to Koch. Again the trails of these two were destined to cross. Both wished to track down the microbe that was the cause of the plague. Pasteur was too absorbed to leave. He sent his devoted assistants, Roux and Thullier. Koch packed up his microscopes and equipment and, with his friend, Gaffky, set off for Egypt, there to slave over the bodies of the dead. Then, as suddenly as it had come, the scourge abated. But not before it had claimed the life of Thullier—another soldier who fell, fighting for a human cause. The words of Koch, recited over the grave of the dead young scientist, might serve as an epitaph for all such: "These wreaths are very simple, but they are laurel—such as are given the brave!"

Hardly had the leaves grown brown upon the grave before the intrepid Koch was himself walking unflinchingly, even carelessly, into an even greater danger zone. When he found himself balked in Egypt, the stolid little German urged that he be transferred to India where, as he pointed out, cholera epidemics were continually reappearing. A few weeks later found him in Calcutta, bending day and night over the dead bodies of dark-skinned men, taking bits from this organ and from that, putting the bits under his microscope and never considering the hazard to his own life. At last his researches ended! Koch had discovered the germ of cholera! Little bacilli that looked like the commas of our punctuation were the undoubted causes of the plague. They became known as the "comma bacilli" of Koch. They did not merely suspend the idea of the sentence, as they do in lexicography—they usually ended the sentence—with death. Koch had tracked the germ to drinking water, to clothes, to beds and to pools where men and women bathed. He described its contagiousness and announced that its extinction could be accomplished only by proper sanitation. When Koch returned to Berlin, the Emperor Frederick greeted him with the "Order of the Star" and throngs cheered him for his marvelous achievements. Koch responded with a modesty that verged on humility, "There is no great merit in my discovery. I merely came upon regions where gold was still lying by the wayside."

Incidentally, while in Egypt, he discovered the microörganism of Egyptian ophthalmia, or infectious conjunctivitis.

Koch was absolutely unselfish in his work. He founded the greatest school of scientific investigation in Europe and his pupils have all reached high rungs on the ladder of fame. Personally he introduced dry heat sterilization. He showed how cholera could be prevented by proper filtration of the water. He devised methods of preventive inoculation in many diseases of man and animals and made extensive studies in tropical diseases, especially sleeping sickness and recurrent fever in German East Africa. He also established methods of controlling typhoid which have been universally adopted. But chief of all, his name is connected with the conquest of the great white plague, tuberculosis. At Koch's time, one in every seven recorded deaths was due to this malignant disease. It was the very scythe of the great Reaper. Koch not only discovered the cause but established means for its early diagnosis and attempted to find vaccines for its cure. In this he was not altogether successful. But since his clarification of the whole subject, the mortality rate of tuberculosis has been diminished over fifty per cent. And the hope that springs eternal in the tubercular breast has achieved some reason for its existence.

Koch passed away in 1910, fifteen years after Pasteur. Both men died in their scientific boots. Between them there existed a harmony born of scientific interest in their attitude toward humanity and a temperamental enmity fanned by a loyalty to their homelands. Both left great schools of fellow workers who carried on to achievement after achievement under the spell of the geniuses who inspired them.

At this stage of the story of health, in so far as the progress of bacteriology and our knowledge of infectious diseases is concerned, only the briefest summary is possible. The roster of names that glow with imperishable glory in the annals of science is so great, their sacrifices so laudable, and their work so magnificently extensive in their supreme business of saving human lives and promoting human welfare, that to mention them all would require a veritable encyclopedia.

While Koch was still alive, Gaffky and Eberth, working in his laboratory, discovered the bacillus of typhoid fever. During the Spanish-American War, this little germ killed many more of our soldiers than Spanish bullets. During the recent war, this disease was

practically stamped out because of the prophylactic or preventive inoculations that were given every man who went to the front. Every gun-shot wound is treated with an antitoxin against tetanus, or lockjaw, and this dreaded consequence of pistol play has been eliminated. The anti-lockjaw serum was the greatest single issue in making our Fourth of July safe and sane.

The bubonic plague, known as the black death, has practically been eradicated due to the researches of the bacteriologists.

Perhaps the story of diphtheria deserves special mention. Here, Frederick Loeffler and his co-worker, Klebs, discovered the germ that produced this horrible affliction. During epidemics, its death toll had been unspeakable. In studying the nature of the infection caused by the diphtheria bacilli, Loeffler found that after death no trace of them could be found in any part of the body except the membranes that they produced in the nose and throat. How then did they kill? And here for the first time it became apparent not only that the germ was capable of destroying its host by its mechanical presence, but that it might elaborate poisonous substances which might circulate in the blood in the nature of toxins and paralyze the centers that presided over the circulation and respiration.

The germs were grown in broth and then filtered out of their nutrient medium and it was found that the medium in which they grew was a poison of far more virulent intensity than the germ itself. Roux, a confrère of Pasteur's, was the first to extract this poison.

At the same time, Behring, who was an assistant in Koch's laboratory and who began life as a poet, permitted his poetic imagination to wander to more practical channels. Dismounting from Pegasus who carried his riders to Olympian heights, he eventually utilized old Dobbin who, wingless, soared to far greater heights of usefulness and sacrifice, for it was the horse who gave Behring antitoxin in commercial quantities and helped him conquer the pest of diphtheria. But, we are ahead of our story. Behring began by trying chemical agents upon the diphtheritic membrane. Some cases survived. Others died. Slowly it dawned upon him, as it had upon Pasteur, that perhaps some children were immune to diphtheria, even as animals were to anthrax. So he infected some animals with

Loeffler's germ and when they survived, he injected some of their blood into other animals and then infected them with diphtheria. And here a great miracle revealed itself. The immunized animals did not get the disease. And so the first antitoxin made its appearance and since then has been one of the greatest godsends of modern scientific achievement. To-day, we are able to test our children to find out which are susceptible and which are immune to the disease, and if all parents were quick-witted enough to avail themselves of the opportunity of this simple test elaborated by Dr. Schick, now of New York, diphtheria would vanish from all civilized communities.

Life could now be defined in new terms. From the first cry of the infant when his birth was hailed with great rejoicing to his last sound when his eyes were closed in perpetual sleep, life was but a struggle against death. Man was constantly surrounded by an infinite universe of infinitesimal enemies—enemies that entered his very entrails with every breath, with every mouthful of food and with every contact with the phenomenal world. His capacity for resisting them is called immunity. And it had now been established that the battleground was the blood and that in the blood substances were formed to destroy the invading hosts and render man safe against subsequent infections. How Nature performed these miracles and in how many ways was still subject for investigation.

It was the erratic, tempestuous young Russian Jew, Elie Metchnikoff, who first came upon the wonders of this mysterious microscopic warfare. Metchnikoff would have been branded to-day as a "red," a radical, and even worse. He might have been deported from this land long since as an undesirable agitator, for, in his youth, he could have been found with his university comrades talking long into the night in defense of atheism and nihilism. He was fortunate to escape the Czar's spies and Siberia. His was a stormy, groping mind. He lacked all the scientific precision that marked a Koch. He barely knew what he was doing or why he was doing it. He did not know that he intended to be a scientist and he fumbled neurotically around. With the egotism of such a nature, he decided that he was misunderstood and unappreciated and decided to kill himself. But just at that moment he became interested in living things. He left his "unappreciative" Russia and appeared at a German University where he was snubbed because he was a Jew.

Again he thought of suicide, but this time, while groping for a pistol, he picked up a volume of Darwin's "Origin of Species," and he began to read. He forgot the gun. The finger that might have pulled a trigger, was avidly turning the pages of a book. The evolutionary theory so startled and absorbed him that he started for home, dreaming of the amazing rise of man out of low forms of life. His imagination was stirred. He had something to live for. He was going to spend his life finding new clews to uphold Darwin's theory.

He turned to starfish, sponges and other low forms of life to study early evolutionary steps and, at the same time, looked within for microscopic evidences. One day, while attempting to watch the larvæ of the starfish, he found it necessary to use a dye to color the sections which he wished to observe under the microscope. It was then his attention was directed to a strange phenomenon. He saw minute cells approach the dye substance and begin to devour it. He had previously noticed these nomadic vagabond cells circulating in the blood, but the rôle they played had never occurred to him or to anybody else. Leaping at a conclusion without any further research, Metchnikoff decided that these were friendly cells which leaped into action when any enemy entered the blood stream. He named them "phagocytes" which, literally translated from the Greek, means "a devouring cell." To-day we are well aware of the protective part played by the white blood cells. When at any time you feel the icy fingers of a chill playing a tattoo up your spine and when after a shorter or longer period your head is throbbing with uncomfortable heat, you send for your doctor.

And one of the first things he does is to take a blood count. He is anxious to know the number of your white cells and to find out if a particular type is multiplying more rapidly than others. Whenever infection assails us, Nature establishes its defense by sending these phagocytic reserve troops into the combat.

Metchnikoff did not know this as yet. With insufficient proof he announced to the world that he had discovered the enemy of bacteria. The hurly-burly of modern life with its hectic pace was already having its influence upon the world of science. Unlike his patient and painstaking predecessors, Metchnikoff took no time to verify his conclusions, but having stumbled upon a discovery, proceeded by

speech and pamphlet to Barnum himself into the sacred cathedrals of science. He started a war with Behring as to whether it was the serum or the white cells that destroyed bacteria. The conflict eventually drove Metchnikoff to experiment and he actually saw under the microscope, his phagocytes devouring microbes. Both Behring and Metchnikoff were so stirred by their own theories that they forgot to realize the fact that both serum and cells were factors in immunity.

The blood, the only fluid tissue in the body, was now being studied with exhaustive avidity and application. One by one it revealed its secrets to science. The clinical picture of the blood and its biological reactions, its physiology and its chemistry contributed an enormous chapter to the progress of the story of health. Pictures of the blood and variations in its composition and reactions determined the nature of many diseases and indicated the prognosis of many others.

Perhaps the most practically important result of these investigations must be credited to one Jules Bordet, a young Belgian assistant of Metchnikoff. Bordet first discovered the difference between human and animal blood, a fact which has been of considerable importance to criminology. He also found that the blood cells of one animal were destroyed by the serum of another and that this property of the serum was lost when it was heated to 56 degrees. Therefore, he said, the serum must contain a substance which is destroyed by heat and deprives it of an active immunizing factor. This phenomenon was applied by Wassermann in the diagnosis of syphilis. Syphilis is a disease of such protean character, disguising itself in so many insidious masquerades, that it always presented a great problem to the clinical eye of the diagnostician. With the aid of the Wassermann test, syphilis can be diagnosed with almost unerring precision.

It is true that the Old World must be credited with the discovery of the "scratch in time" and the numerous benefits that have accrued to mankind through its timely application. The scratch in time, or as it had now developed the "stick" in time, had saved not nine, but nine millions of lives. We proudly boast to-day that America feeds the world. This might not have been one of our just vainglories had it not been for an American doctor. Out in our

glorious West, where cattle had been multiplying by millions and supplying sustenance to a hungry universe, a terrified call for help was heard. The rangers were in despair. Their best cattle were dying as the result of a pestilence they called "Texas fever." Theobald Smith, an American disciple of Robert Koch, who was working with the Bureau of Animal Industry at Washington, set himself to the task of discovering the cause of this dread malady. He observed that the cattle were infested with a pesky little bug called the tick, and in it he sought for the cause of the scourge. While much laughter was going on in Washington, Smith was spending heart-breaking months out in the hot sun of the prairies until he had proved his case and found not only that the tick carried the disease to the cattle, but that it transmitted the infective agent to its own progeny. And by destroying the tick and its eggs, he practically saved the cattle industry of America.

More than this, insects were now to be studied as the carriers of disease. He had set in motion a rolling stone that was gathering the moss of every clime. Zealous missionaries popped up everywhere, anxious to risk their lives in pursuit of bacterial quarry and in partaking in the war against disease.

Out from the Pasteur Institute rushed M. Yersin, headed for China where hundreds were dying from the deadly bubonic plague. Within a few months, he was living in the slums of Hongkong, heart of the plague zone. He exposed himself to the greatest dangers with quiet resignation and worked with unflinching courage. And then, one day, there came to Paris his terse, but thorough report: "The epidemic rages principally in the quarters of the poorer classes, which are rat-infested. In the infected sections, many rats die of the plague. The peculiar aptitude certain animals possess to contract plague enables me to undertake experimental study under very favorable circumstances. It seemed obvious that the first thing to do was to look for the microbe in the blood of patients. When I inoculated rats or guinea pigs with this bubonic blood, the animals died. It seems likely that rats constitute its principal vehicle of dissemination, but I have learned, too, that flies contract the disease and die of it, and therefore become agents of its transmission."

In this casual presentation of the dénouement of a tensely dramatic situation in the far-away Orient, humanity learned another

vital fact:—not only insects, but rodents could carry disease. And it was not long after that Yersin and the Japanese, Kitasato, discovered the specific bacillus of the plague.

Then, out from London, headed for the African fastnesses, had gone David Bruce and his bride of a few months on the trail of the tsetse fly and mysteries hidden in jungle and brackish swamp. Bruce was attached to the British Army Medical Service. He was literally projected into his career for, having challenged his colonel to a fist fight, he was sent by a court-martial to the Island of Malta. And it so happened that the soldiers imprisoned there were suffering from a malady they called "Malta fever." Since Bruce was the one man on the island capable of coping with such a situation, he was given the opportunity. He had a thousand dollars and he used this to buy hundreds of monkeys, using them for experiments until he found the specific germ. The army officials thought to reward him and he was sent back to England to teach. But it has been said that "They who can, do—and they who cannot, teach!" And he pleaded for a chance to go to Africa, India—anywhere, so long as it provided the thrill of the germ chase. His wife had become an equally adventurous scientist, and thereafter they worked side by side.

Off they went by ox-team into the heart of Zululand, with the tsetse flies swarming about them, with wild animals menacing their progress and the tropic suns scorching them. Their first assignment was to learn something about a disease the natives called "nagana," an ailment that seized their horses and cattle. The Bruces set up their station at Ubombo, high above the plains that stretched out below,—so fertile, yet so deadly. Then came a repetition of what had been going on in so many places—a little cut, a few drops of blood on a slide, or incubated on nutrient media, a peep through a microscope, and another new microbe. And again the question of how these enemies found their way into the blood. This time the answer lay with the tsetse flies. He attracted great hordes of flies to his rude laboratory using a wooden horse as a decoy.

It sounds simple indeed, to state in cold type that soon Bruce discovered that the tsetse flies were carriers of the disease, even as were Smith's Texas ticks. We leave it to the romantic novelist to describe the months of battling in primitive jungle land under a

sweltering sun, at the mercy of beast, reptile and insect, gathering material and straining over it in the dim light of the short-lived cool of the late evening. But it was this battle against the tsetse fly, the fight of a young man and his wife, that made the African jungle accessible to the white man.

This same tsetse fly appeared as the carrier of the dread sleeping-sickness and it was Bruce again who was sent into the valley of certain Death to fight its little winged pensioners. He found that men afflicted with the disease had a peculiar organism called "trypanosome" in the blood, and that this was the result of fly bites. He warned the natives to avoid the brackish waters where the flies bred and the plague waned.

Malaria was another disease that throughout centuries had made its inroads on human comfort and health. While not directly a killer, its chills and fever and its widely diversified pathological manifestations had rendered many an ambitious and active life unfit to pursue its self-imposed missions.

Laveran, a Frenchman, first discovered in 1880 that the disease was due to a parasite. And in 1897, Ross, an English army surgeon in Indian service found that the mosquito was the intermediary host to the parasite. Since then we have all learned to hate the mosquito more than ever and his breeding places are gradually being destroyed to the practical eradication of disease in civilized communities.

And there was Walter Reed and the Yellow Fever Commission that went into Cuba. If tense and tragic drama goes hand in hand with this particular crusade in the interest of health, it is because men and not animals had to be used in experiment. Men had to volunteer, because rats, guinea pigs and rabbits could not be inoculated with the disease. Test after test showed the animals to be immune. Yet, with death facing them, there were innumerable unsung heroes who stepped up and said, "Take us!"

In military life, especially during warfare, where men are thrown together into crowded barracks, contagion is a word more to be feared than court-martial. When yellow fever appeared, it had always been considered rankly contagious and men were segregated. There was one old Dr. Finley stationed in Cuba who scoffed at the prevalent idea that it was contagious and that the usual precautions

had to be taken. Empiricism, rather than scientific observation, had taught him that yellow fever occurred only during mosquito season. When Walter Reed arrived, he emphasized the point that the nurses who took care of the patients did not develop the disease and, viewing the theory of Finley with tolerance, he set himself to the task of investigation. He turned to members of his Commission one night and remarked bluntly and unemotionally that he needed men who would allow themselves to be bitten by mosquitoes and others who would submit to being confined in rooms where yellow fever patients had died.

Heroes of health fight quietly. No statues rise to them and in the minds of the millions they are anonymous figures. The men who risk their lives in the interest of human welfare have no trumpets to blare their sacrifices. And often, they are actually fearful that public protest may arise out of experiments which, for better or for worse, are intended to alleviate human suffering.

Reed realized this. He proceeded slowly. He knew he had no choice in the matter. He must either experiment on man under "fool-proof" circumstances or fail altogether. He explained that those who enlisted would have to submit to being locked in a room where their sheets, pillow-cases, handkerchiefs, towels and general surroundings had been contaminated by and even soaked in the foul mucus taken from yellow fever sufferers. If he were wrong, and yellow fever was contagious, they were as good as dead. If he were right, they walked out alive. And science learned another important fact. Three men stepped forward—a certain Dr. Cook and two soldiers named Jarnegan and Polk. None of them had any illusions about the glory that would accrue to them; they were well aware that the world would forget overnight whether they lived or died; they refused even to accept the fairly generous fee offered to those who might come out alive. Such bravery cannot, after all, be immortalized either in stone or in story. In battle, a man at least has a chance, but here were three men ready to undertake an experiment in which no one could say with any certainty whether or not he had any chance at all. And, for twenty days, they shared this foul room. And they came out, and lived! Reed had proved to his satisfaction that the disease was not contagious.

It now remained to be proved whether or not the insect theory

was sound. And he felt that any tests that might be made should begin with members of his own party. He explained to his fellows that they should set the example, and let any soldiers who wished, follow. Dr. James Carroll, a picturesque product of the north woods, was first to roll up his sleeve. Upon his arm was placed a mosquito which had been allowed to dine long and heartily upon fever victims. Within a few weeks Carroll lay tossing on his cot, his heart fluttering weakly and his fever-parched throat muttering his delirium. Miraculously, he recovered. Reed now had the proof he needed.

But, meanwhile, still further evidence was coming to hand. Jesse Lazear, a member of the experimental party, had been doubtful concerning the mosquito theory. As he went about his laboratorial work, a mosquito perched upon his hand. He saw it, but did not brush it off. Rather he shrugged his shoulders. He was willing to take the chance. Either he would or he wouldn't be affected. A few weeks later, Lazear was dead—a martyr to his doubt. Reed himself then stepped up and announced himself ready to be subject for the next test. His comrades insisted that his age was against him. They would not tolerate the idea, and Reed did not get his opportunity for immediate sacrifice. Thereafter, innumerable buck privates let their strong right arms become the playgrounds of life or death until equivocal proof had become established fact.

But there is nothing new under the sun. The idea that insects and vermin were proven carriers of disease had marked a new and tremendous stride forward in bacteriological investigation. But for hundreds of thousands of years, man has seen what he could not understand. As old as time are the legends that the savage tribes are aware of the fact that insects play important rôles in the transmission of disease. We, who hold the knowledge of the witch doctors to ridicule and scorn, might have learned a great deal if we had pried into their secrets. Not only did the ancient Egyptians recognize the insects as agencies of malady, but they created amulets in the shapes of flies and bugs to ward off their evil influences. On most of the charms dedicated to Norgal, the Mesopotamian god of disease, can be found reproductions of a gnat. The Sanscrit version of the Hindu Susruta tells of an intuitive appreciation of the buzzing enemies. Beelzebub was a "fly demon" and Pliny makes mention

of two humorous gods, Myiagros and Myiodes, who were presumed to drive flies away from the pates of bald-headed men.

The savage tribes of Africa have for uncounted years had words that signified "the little demons that get into the blood out of the air." And when the patient was racked by the chills and fever that followed exposure to insects, he was given of "the bitter root to chew." "The bitter root" was nothing else than a preparation similar to our quinine which we use as a specific against malaria.

Of greatest interest is the following: Von Wagner Jaurag of Vienna was recently awarded the Nobel prize for his treatment of the heretofore unconquerable paresis, by infecting the afflicted with malaria. The intense fever generated by the malarial parasite is supposed to destroy the more baneful germ that causes the tragic consequences of syphilis. Among the Irambas it had long been the custom to let a mosquito bite the victim of paralysis.

Jaurag made his observation in the Italian campaign of the late war. Malaria was very prevalent and so was syphilis, and he noticed that in soldiers infected with both diseases syphilis waned or was very mild; and he applied his observations to paretic patients with more than hopeful results.

All of these discoveries have contributed considerably to the story of health. Our modern sanitation is a direct outgrowth of this new knowledge. We use exterminators to keep our homes free from vermin and insects. We drain the swamps that breed mosquitoes, or cover them with oil. We teach our children to swat the fly as soon as they are old enough to understand. We ventilate and fumigate to prevent the spread of infection and contagion; our farmyards are kept under scrutiny and inspection so that only healthy animals may achieve slaughter and our milk is obtained from contented as well as uncontaminated cattle. Even man's truest animal friend, the dog, has been muzzled and licensed until the dread hydrophobia has practically been eliminated as a disease. All our foodstuffs sold in jars and tins are proven bacteria-free and ptomaine-free before they are marketed. Only where the greed of man or his carelessness defies the rules that hygiene and sanitation have prescribed, does the disease actually stalk in upon unsuspecting individuals.

Perhaps the greatest of the more or less recent discoveries of the causes of disease, was the finding of that extremely delicate and

elusive spirillum that is responsible for the malady that is transmitted by the sins of the fathers—syphilis. Like a demon's curse, its pall had hung over civilization. From den and dungeon to castle and cathedral, it spared not the wanton nor the chaste, branding with horrible consequences, matron and man, youth and innocent infant. It was Schaudinn, a great German zoölogist, who first saw the wriggling damnations under the microscope and proved them the unreasoning menace responsible for the dreaded disease.

The cause revealed (it may take us somewhat out of the strict confines of our theme) introduced the man who was fated to approach with chemical arsenal these mites of malignancy, and he practically succeeded in conquering them. Paul Ehrlich, who discovered salvarsan—or 606, as it is popularly known—was a pupil of the great Koch. With Teutonic persistency and diligence, Ehrlich plied his trade of investigating the chemistry of various dyestuffs and invented many differential stains for tissues and germs. He found that certain tissues and certain germs had peculiar affinities for specific dyes. He then wondered whether there might not be chemical substances with similar affinities for special tissues and germs.

He had secured an inexhaustible supply of the deadly trypanosomes from Laveran and, having infected white mice, injected them with hundreds of different dyes in the hope of finding one that would kill the germ without killing the mouse. After some four hundred experiments, he finally found a brilliant red dye that had a special affinity for the trypanosome. He called it Trypan Red. He was not successful in every application of the dye, so he continued to work; and his 606th attempt gave him salvarsan, the most effective protoplasmic poison that we have. With salvarsan he hoped to wipe out syphilis at one blow. And modern statistics go to show that if salvarsan is administered early enough and in sufficient quantity, a great majority of the cases are cured. The boon to mankind is inconceivable. Twenty years ago a syphilitic person was a far greater menace to society than a leper. Diagnosis of the disease was uncertain, and the treatment long continued, and the cure very slow. In the meantime, the patient was frequently capable of transmitting the disease in a hundred innocent ways.

The great play by Brieux called "Damaged Goods" gives an excellent and dramatic portrayal of the problem. To-day, thanks to

Paul Ehrlich, syphilis has lost many of its terrors. Schaudinn has helped us to diagnose it in its earlier stages with absolute positiveness. Wassermann has further contributed in enabling us to detect its presence when no symptoms are apparent and Ehrlich has given us the drug that will render the most active case innocuous within a short time after its administration. Moreover, the most dreaded consequences of the disease, its later affections of the brain and the spinal cord resulting in paresis and locomotor ataxia can now be determined by a study of the spinal fluid, where its chemistry, its biological reactions, its cell content and its reaction to the Wassermann test reveal the impending shadows that presage future tragedies.

All over the world to-day, doctors are tracking down bacteria and seeking to find serums and vaccines and antitoxins to overcome their devastating activities. Here and there they meet with partial success, at other times they are confronted with failure. Tuberculosis, pneumonia, gonorrhea, meningitis, scarlet fever and whooping cough, as well as practically every other infectious disease, are being approached from the standpoint of preventing their occurrence by immunizing the patient against them or rendering them mild and short-lived by fighting their poisons with the specific antipoisons that the germs themselves engender.

The fight goes on. Not every case is successfully treated. Human beings continue to die but the opportunity for life has been tremendously improved. Where two generations ago the average life span was between thirty and thirty-five years, to-day it is between forty and forty-five in spite of the fact that our existences have been made more precarious thanks to our modern inventions. After all is said and done, man is not a test tube and there are many who believe that there is a "Divinity that shapes our ends." But it may be said without vainglory, to the credit of the physician, of those earnest workers who have taken the treatment of disease out of chaos and brought it into the light of scientific practice, that they have given the Divinity many a holiday.

CHAPTER XIII

In the Arms of Morpheus

It is logical to assume that, if any thought of man has found expression in a graven symbol or a written word, this thought has lived before in the concrete knowledge of mankind for an indefinite period of time. We, to-day, who regard anæsthesia as a modern miracle, without which the life-saving science of surgery could have made but little progress over the stone-cutters of the days of Pepys, will find ourselves in considerable error, if we pause to investigate the origin of that artificial sleep which not only "knits up the raveled sleave of care," but permits us to sew buttons into the human interior.

Let us leave all quarrels and quibblings concerning the antiquity and truth of the Bible to Tennessee. However, in Genesis, Chapter II, Verse 21, occurs a startling revelation of what must have been a time-honored custom.

"And the Lord God caused a deep sleep to fall upon Adam, and he slept; and he took one of his ribs, and closed up the flesh instead thereof."

Notwithstanding the faith of the casual zealot, it is not sacrilegious to suppose that man endowed his God with few gifts of power that he did not himself possess. Man, moreover, had learned that ribs were bones most easily spared; yet such an operation, without anæsthesia, would have been a "ticklish" proposition, and Adam, if conscious, might have laughed himself out of a mate.

It is probable that primitive man saw a snake coil about the neck of its victim, and leave it prostrate, unconscious, and yet possessed of the breath of life. Pressure about the neck could produce unconsciousness without death. In the neck lie the carotid arteries which carry the blood to the brain, and curiously enough the literal translation of the Greek term for carotid is "artery of sleep." According to Caspar Hoffmann, compression of the carotid arteries was

practiced by the ancient Assyrians before the operation of circumcision. It is easy to understand how depriving the brain of circulation for a few minutes would produce an epileptic incident, which in turn is followed by coma. Choking, or deprivation of air, is also productive of coma, but it is too dangerous as a method. The coma may remain permanent; and the introduction of fresh air will restore consciousness so quickly that the method would be inadequate for all practical purposes.

The Egyptians of antiquity are believed to have used a concoction of Indian hemp and poppy juice to induce drowsiness before an operation, and the "sorrow-easing drug" which, according to the "Odyssey," Helen gave Ulysses, probably was a wine of opium and hasheesh. The "wine of the condemned," mentioned by the prophet Amos, was probably a cocktail of similar ingredients.

Crucifixion was a common Jewish punishment for malefactors. Frequently, to ease the terrible death of the victims, a "wine of the condemned" was given them upon a sponge. This may have been the "wine mingled with myrrh" that, according to St. Mark, was offered to Christ, with the object of lessening his agony.

The Talmud states a poetic paraphrase, "Give a stupefying drink to him who loseth his life, and wine to those that carry bitterness in their hearts."

Pain, of all human sensations, is the one most poignantly felt, and the one most passionately to be avoided. Methods for deadening his sensibility to it must have been among the most urgent searches of man. Every plant that grew was investigated in the hope of finding some nepenthe for the woe of pain. To-day we have opium and its derivatives, belladonna, hyoscyamus, and a host of synthetic coal-tars, and specific chemicals, that help the modern physician to assuage the cry of tortured nerves with speedy relief. But the history of the origin of these preparations is not without romantic interest.

Mysterious and quaint are the associations which cluster about one of the earliest narcotics, mandragora, or mandrake. The Babylonians used it in 2000 B.C. Theophrastus is the earliest writer on botany to describe the virtues of the plant, which had the property of inducing sleep. The Greeks gave it the name of "Circeum," from the witch Circe. They believed that an evil spirit dwelt in it,

for, when uprooted, it uttered such frightful shrieks that no mortal man might hear them, and live. To prevent this catastrophe, a dog was used in gathering the plant, and the animal was sacrificed to the rage of the vegetable demon. The ceremony was austere. In the dead of night the dog was tied to the plant; the earth about the roots was loosened. In his struggles to free himself, the dog tore the mandrake, whose roots were supposed to have human form, screaming from its bed, and succumbed in fatal fright to the horrifying cries of the plant. Frequently the man accompanying the dog (was he the first vivisectionist?) blew a horn so that the sound of the instrument might deafen his own ears to the heart-rending lamentations of the mandrake, and so spare his life.

The first mention of mandragora, as an anæsthetic, is made by Dioscorides (100 A.D.), who states that "three wineglassfuls of a liquid preparation of the root was given to those about to be cut or cauterized, when, being thrown into a deep sleep, they do not feel any pain." It is to be remembered that those Grecian wineglasses were of generous proportions. Mandrake is mentioned by ancient writers, who describe its narcotic qualities in many proven practices. In the Dark and Middle Ages, Galen and Avicenna still used the drug as a sedative and hypnotic. Celsus recommended a pillow of mandrake apples for insomnia. A modern English doctor tried a draught prepared according to an ancient formula, and wrote that "the phenomena repeated themselves with all faithfulness."

In all countries the search of the panacea for pain was most naturally confined to plants that were locally indigenous. Ancient records relegate the inhalations of the fumes of burning Indian hemp to a very primitive period in Hindu civilization. One instance may be quoted: an operation performed on King Bhoga.

The monarch was suffering from severe headaches and a surgical operation was considered imperative to give him relief. His doctors administered a drug called "Sammohini," which rendered him completely insensible. They then trepanned his skull, removed the cause of his complaint, sewed the wound and dressed it, and then administered another drug, "Sangivini," to restore his majesty to consciousness.

Chinese medical literature, dating back to pre-Christian eras, is full of references to the use of stupefying drugs. And it is not

improbable that China's somnolence is largely due to the generalized use of drugs, especially opium, among its people. Learning its effect in the lessening of physical pain, they usurped its beneficent properties when intelligently used, to give them harbor from the stern realities of existence and the psychically painful experiences of life.

The Middle Ages contribute many interesting additions to the story of anæsthesia. It is inhuman to suppose that operations, necessitated by wounds sustained on the battlefield, where limbs had to be sacrificed to save lives, were performed without the blessing of induced sleep. Think of amputations at the thigh, and molten lead poured on the vast wound to stay the bleeding—such as was the practice as late as our own Civil War—and try to think of it without anæsthesia! The shock alone would have caused death in almost every instance.

Theodoric, a monk-physician, who practiced surgery in the latter part of the fifteenth century, mentioned for the first time "the sleeping sponge," adopted by his father, Hugo of Lucca, a Tuscan physician, who had, in turn, come upon his method from traditional teachings. The prescription for the sponge was fantastically intricate, though its application was simple enough. "Take of opium, of the juice of the unripe mulberry, of hyoscyamus, of the juice of hemlock (with which Socrates is said to have snuffed out the candle of life), of the juices of the leaves of mandragora, of wood ivy, of forest mulberry, of the seeds of lettuce, of the dock, which has large round apples, and of the water-hemlock, each an ounce; mix all these in a brazen vessel, and then place in it a new sponge; let the whole boil as long as the sun lasts on the dog-days, until the sponge consumes it all, and has boiled away in it. . . . As oft as there shall be need of it, place this sponge in hot water for an hour, and let it be applied to the nostrils of him who is to be operated on until he has fallen asleep, and so let the surgery be performed."

It is recorded that the sleep so induced was so profound that it often lasted for days, and that the patient had to be restored to consciousness by another sponge dipped in vinegar. There were many variations in the formula and use of the aforementioned knockout, but, in the main, the surgeons used similar mixtures. The

poets and writers of medieval romance and drama constantly allude to "sleeping and love potions." It seems that all of the narcotics used had an aphrodisiac effect in smaller doses, or produced dreams filled with erotic visions. The "Decameron," of Boccaccio, is full of stories of conjugal deception and amatory excursion, in which the "sleeping potion" plays a prominent part in plotting clandestine episodes. Shakespeare, in "Romeo and Juliet," speaks learnedly, and in some detail, on the nature and action of soporifics, or "drowsy syrups," and, in "Macbeth," stupefies the guards of Duncan with wine. Many contemporaneous writers mention anæsthesia as a means of rendering surgery painless.

From time to time, till almost the middle of the nineteenth century, various means of producing insensibility had their temporary vogues. There must have been many accidents and many unpleasantnesses associated with their administration, otherwise one method would have had preference, and come into general use. Morgagni, as late as 1750, reverted to compression of the carotid arteries. It is not uncommon for modern physicians still to resort to carotid compression in the differentiation of true brain injury and malingering simulation. The method is precarious, not without danger, and the unconsciousness produced is a kind of stertor in which the patient becomes blue, and the respiration and pulse become irregular. Patients with a brain injury become dizzy very quickly and careful attention is needed to keep them from going beyond this primary phase of brain anæmia.

So many fatalities must have occurred, due to the inaccurate and uncertain doses of narcotics given, that many preferred to submit to operation without anæsthesia. It is recorded that Lord Nelson at Teneriffe withstood the agonizing pain of amputation of the right arm without taking any sedative. It was not until the advances in chemistry definitely established the nature of the substances used, and discovered new anæsthetics, that mankind was completely delivered from the qualms and tortures attending surgical operations.

About 1767 Joseph Priestley, an English chemist, discovered a method of liberating and collecting gases. He found that certain gases, such as carbonic acid gas, could be absorbed and compressed in water, and thus our aerated waters had their origin. His isolation of oxygen led to innumerable experiments with the inhalation

of gases, and to the study of their effect upon the tissues. Priestley discovered nitrous oxide, or "laughing gas," in 1776 and, in his own way, established a declaration of independence from pain. Lavoisier carried Priestley's investigations to the point of actually "discovering" oxygen, while Laplace went still further by showing human respiration to be analogous to combustion.

Doubt was rampant and progress was slow. In 1798, Humphry Davy was appointed superintendent of a Medical Pneumatic Institution at Bristol. Here he carried on his notable experiments with nitrous oxide, inhaling it from a box in measured quantities. One day he had a severe toothache, and found to his great delight that inhalation of the gas relieved the pain. It was then that he first suggested its use in surgery.

As early as 1798, small doses of ether were given by inhalation to relieve the irritable cough of consumption, and ten years later a Dr. Woolcombe, of Plymouth, prescribed for Lady Martin, a patient afflicted with asthma, the inhalation of ether to relieve her paroxysms. Lady Martin found that the inhalation caused her to become unconscious, but that she would recover in a short time. This phenomenon was, however, overlooked, even as Sir Humphry Davy's intimations were neglected. It was not until 1818 that Faraday stated that ether produced effects similar to nitrous oxide. About this time Dr. Thompson of Glasgow would occasionally amuse his students by permitting some of them to inhale ether and nitrous oxide until they were intoxicated. Their antics were found extremely ludicrous. He noticed, however, that they occasionally became unconscious, and were then insensitive to pinchings and pinpricks. It is remarkable that so many experimenters had stood on the very brink of applying the discovery of one of the greatest boons to mankind, yet for thirty years the blessing of anæsthesia was witheld from humanity.

Before proceeding to the story of modern anæsthesia, let us consider, briefly, certain mystical methods of producing loss of sensation that became popular in Europe in the middle of the eighteenth century.

In earlier chapters we have seen how the priest-physicians of old effected cures by inducing their patients to sleep, and then, by a process of mental suggestion, sought to remove their afflictions.

The healing influence of the "laying on of hands" is vouched for in Biblical lore. About 1760, Mesner, a student of astronomy in Vienna, was greatly influenced by the power of the magnet. Following old and outworn trails left far behind by Paracelsus, he conceived the notion that magnetism was a universal occult force resident in all of us. Some individuals, he believed, had been more lavishly endowed with this magnetism than others and could effect cures upon their less fortunate brothers by transmitting this magnetic force. It could be done through the use of magnets, and also by the laying on of hands. The human hand, he reasoned, had a power similar to a magnet.

So he set about practicing his preachment and was holding private séances in Vienna when Maria Theresa decided that some quackery was in the wind, and named a commission to investigate. Mesmer was driven from the country. A few years later he reappeared in Paris, but now he had blossomed forth with all the paraphernalia of the professional cultist and was drawing a great trade to himself.

He is pictured walking into his séances, clad in a light lilac robe. He no longer applied his hands, but used a fancy metallic wand with which to transfer his magnetism. He would enter the room playing a harmonica, feeling that music had certain hypnotic charms. After touching each individual with the wand he would stare "mesmerically" into his eyes. When, however, a critical condition was suspected the séance would become private and he would resort to the mesmeric use of hands.

Later he perfected "magnetic tubs" in which patients stood. Each tub was provided with an iron conductor, which was a ring that came in contact with the patients. These joined hands in order that the "magnetic waves" might pass among them. The sessions must have been quite as amusing as are some of our modern cult fads. At any rate, they brought even the wrath of Paris upon him and again he was requested to leave. Mesmer dropped completely out of sight shortly after the French Revolution. But his practices were picked up and elaborated upon by one Gassner, a priest of the period, who was credited with miraculous cures through the use of magnets.

Those of us who are familiar with the many forms of hysterical

natures or constitutions can readily believe the validity of Mesmer's claims. That he was thrown into eventual disrepute was due to the temporary character of his cures, and the fact that the method succeeded only with susceptible individuals. The vogue persisted, however, in one form or another, for a hundred years. It ran off into various side-tracks. Phrenology, and even ventriloquism, became popular at one time. The Baron Karl von Reichenbach enjoyed a great success with his "odic forces," the idea of which still lives in our ouija boards and similar contraptions.

Still, out of Mesmerism, came a fortunate accident. There was an American doctor, Robert Collier, a surgeon, who believed and practiced mesmerism. One day he was called upon to treat a negro who had been overcome by inhaling the fumes of rum, and who in falling had dislocated his hip. Collier found the muscles relaxed and reduced the dislocation with little effort. He then decided that the unconsciousness produced by mesmerism and that by the inhalation of narcotic vapors were identical in nature. The importance of this error lies in the fact that it gave a new impetus to research in the realm of anæsthesia.

Humphry Davy had announced the anæsthetic properties of nitrous oxide as far back as 1800, but it was not until 1844, when Dr. D. Q. Colton, a popular lecturer on scientific subjects, gave a demonstration of its action at Hartford, Conn., that Horace Wells, a dentist, and one of Dr. Colton's audience, became sufficiently impressed to penetrate deeper into the nature of the gas. A man named Cooley, who had been invited by the lecturer to inhale the gas for the amusement of the audience, fell over the benches and cut himself severely. He became aware of his injury only when he saw he was bleeding. Wells paused and thought. As with Isaac Newton, the apple of circumstance had not fallen upon an unimpressionable head. Wells had a bad tooth—but a good idea. He would have his decayed molar extracted while under the influence of gas. Dr. Colton agreed to give it to him. On the following day, to the amazement of his onlookers, Dr. Riggs, a colleague of Dr. Wells, extracted the tooth. Dr. Wells did not stir. When he awakened, in a few minutes, and saw his tooth still held in the forceps of Dr. Riggs, he discharged the blood from his mouth, and exclaimed: "A new era in tooth-pulling!" Dr. Wells had felt no

pain—and this most famous tooth in history should truly be called the first "wisdom tooth." The principle of general anæsthesia had been established.

The charlatan's dictum is, "Never do a trick more than once." The scientist insists on its constant repetition, until all can do it. Like many other pioneers, Wells came to grief. While demonstrating his technique in Boston, the gasbag was prematurely removed, the patient yelled, and Wells was hissed out of the room. Disheartened by his failure to establish his claims to priority in the administration of anæsthesia, his mind became affected, and at the age of thirty-two he committed suicide by cutting the arteries at his wrists—not, however, without inhaling an anæsthetic to make death painless. This sad event closed the career of another martyr to science; or rather, to the impatient acrimony that a new phase of Truth awakens in the die-hards.

A more brilliant discovery, however, lay in the offing. Dr. W. T. G. Morton, a partner of Dr. Wells, and an assistant in the unfortunate experiment that branded poor Wells an impostor, was determined to find a more efficient substance for producing temporary unconsciousness. C. T. Jackson, a Boston chemist, suggested ether, the properties of which had been known, but which had never been used as a general anæsthetic. On September 30, 1846, Morton shut himself into a room, alone, and inhaled ether. The following is his statement:

"I saturated my handkerchief and inhalted the ether from it. I looked at my watch and soon lost consciousness. As I recovered, I felt a numbness in my limbs and a sensation like nightmare. I thought for a moment I should die, but at length felt a slight tingling in the end of my third finger, and made an effort to press it with my thumb, but without success. At second effort I touched it, but there seemed to be no sensation. I attempted to rise from my chair, but fell back, and looking immediately at my watch, found I had been insensible between seven and eight minutes."

That same evening, a patient called upon Dr. Morton and asked to be mesmerized to have a tooth extracted. Morton gave him ether instead. The experiment was successful. Soon after Dr. Morton appealed to Dr. John C. Warren, from whose clinic Dr. Wells was so ruthlessly expelled, to permit him to use his anæsthetic

upon a patient about to undergo a surgical operation. Warren consented. The date was October 16, 1846. The ether was again successfully given, and a large tumor of the neck was excised without a groan from the patient. Warren then exclaimed, "Gentlemen, this is no humbug!" Morton chose the name "letheon" for his new anæsthetic, but it was Oliver Wendell Holmes who suggested the names "anæsthesia" for the condition, and "anæsthetic" for the agent, and these names have survived. Credit for the famous discovery was divided between Jackson, the chemist who inspired Morton to use ether, and Morton, who put it to practice. Both in fact had followed Collier, although the United States Government honored Jackson with a prize; Morton died broken-hearted. Jackson, like Wells, died insane. Oliver Wendell Holmes suggested the settlement of their dispute for posterity, by proposing one monument symbolizing painless surgery, with statues of both Chemist and Doctor and the inscription to read: "To E(i)ther."

Following the use of ether, other substances were investigated with regard to the anæsthetic value of their volatile vapors. In 1847, Waldic, an English chemist, suggested the use of chloroform —a substance known for about fifteen years and said to have anæsthetic properties. The first experiment with chloroform was made by Dr. James Young Simpson, November 4, 1847, in his own home. The results were similar to those obtained with ether, although the effects were more rapid and more profound. On November 10, 1847, Simpson communicated his discovery to his colleagues at Edinburgh, and five days after chloroform was used for the first time in a major surgical operation with complete success. Many other substances have been used in anæsthesia, but ether and chloroform remain the standard preparations in most operating rooms. There have been many variations and improvements in the methods of administration, too technical to describe in these pages. It will be sufficient to repeat, that general anæsthesia has been responsible for the advancement of animal experimentation, for the progress in physiology and biology, and for the saving of millions of human lives by making life-saving surgery possible.

A great advance in anæsthesia was made by Dr. Jonnesco, a Roumanian, in 1909. He discovered spinal anæsthesia. He found that by injecting certain narcotic substances directly into the spinal

canal, he could produce a sensory paralysis of all tissues below the site and locality of the injection. This method has proven a great boon to those in whom general anæsthesia was contra-indicated, for safe as it usually is no surgeon to-day undertakes an operative risk when his subject is unfit to undergo the rigors of artificial unconsciousness. The contra-indications to general anæsthesia are well known and assiduously avoided.

Within the last twenty years, and especially during the war, a great impetus was given to so-called local anæsthesia. At best, the general anæsthetic is followed by unpleasant after effects. The local anæsthetic permits of painless operation without depriving the patient of consciousness.

Pliny relates that the Egyptians applied to painful wounds a species of rock from Memphis, which was powdered and strewn upon the wound and then moistened with sour wine. Naturally carbonic acid gas was developed locally, and its anæsthetic properties relieved the pain. The ancients also practiced the inunction of various narcotics. Lead and opium wash is still used to-day, as are various plasters for the relief of local pain.

In 1884, Karl Koller, then of Vienna, now of New York, discovered the remarkable properties of cocaine as a local anæsthetic. Koller found that the instillation of a two per cent solution of cocaine into the eye rendered it anæsthetic for about ten minutes. The enormous value of such a drug in ophthalmic operations was immediately recognized and cocaine came into general use. Many synthetic drugs, allied to cocaine, but less toxic, have been discovered. In operations of the eye, ear, nose and throat, they have proven of immense value.

Local anæsthesia has been developed recently to a remarkable degree. Nerves themselves are blocked by the injection of novocaine. Regional operations are done painlessly with the patient retaining full consciousness. Also the sensory endings of nerves are deadened by local infiltration and the injected area is rendered anæsthetic.

The remote has always had an attracting aura of mystery about it. Children cry for the moon. Frequently scientists hitch their wagons to stars, and point their pilgrimages back into the past, or let their flights of fancy plunge them speculatively into the distant future. So does the old become new again. And so it happened

that about fifteen years ago an old method of anæsthesia was unearthed by a German, Dr. Gauss, in the hope that the coming of the stork might be less painful. He took henbane and poppy of Auld Lang Syne, scientifically known as scopolamin and morphine, and in their combination rediscovered a method of producing a degree of mental cloudiness and loss of memory without interfering with the mechanics of childbirth to any great degree. The method had a short vogue. It was not without dangers to the infant. True mothers would rather bear the soon forgotten pains of parturition than submit their offspring to the hazards of asphyxiation. Volatile anæsthetics are safer than those taken internally, because they can be discontinued at will and because their elimination by the lungs is very rapid. Twilight sleep, as Dr. Gauss called his method, soon passed into the evening and night of its own oblivion.

Every day the balm of anæsthesia falls like a miracle upon those of us who are agonized by pain, or in need of surgery. Nothing in the whole realm of human effort has ever contributed as much to human comfort.

CHAPTER XIV

The Kindest Cut of All

SPEAKING of operations! There appears on the Acropolis at Memphis a carving made about 3000 B.C. which shows a human knee, just below which is poised a hand. In the hand is a reproduction of a crude surgical knife. Explaining these symbols are hieroglyphics which, when literally translated, inform the world that a bit of minor surgery is about to be performed. And the victim is asking one of the world's oldest and most familiar questions: "Doctor, will it hurt?"

And, again, there is a very ancient Singhalese myth concerning a certain virtuous and kindly monarch, King Buddhadisa. It is recorded that this good king felt so keenly for the health of his people that he went among them prepared for any medical emergency that might arise. Now it so happened that in this good king's realm was a certain herdsman who, upon a warm day, bent over a pool to drink and in so doing, breathed some water into his head. In this water were some frog's eggs. These entered his head, hatched, and in good time the whole countryside stood witness to the fact that a frog was croaking in his cranium. This news reached the ears of the king who was ever ready to aid his lowliest subject. The tale goes on to say that the king operated upon the poor fellow, extracted the frog, sewed up the wound and went upon his way leaving the herdsman to recover. At any rate, it was the frog and not the man that croaked.

Granted that this story is entirely legendary, and without the slightest basis in fact, still the very nature of it proves that the minds of the times could conceive such a difficult and extraordinary feat of surgery. It is only fair to concede that it may have been inspired by some difficult cranial operation; particularly since it is fortified by other seemingly fabulous tales from the "Jivaka," an ancient Hindu myth. Here we encounter the somewhat startling

revelation that, several centuries before the Christian era, there existed a dream of such a device as our modern X-ray. Jivaka, in one of the tales, comes into possession of certain magic sticks, or Bhaisa Jyarja. When these were held over the body of a patient, they took on what we know as radioactive properties. Jivaka found that he could make flesh transparent by means of this magic light and could observe all that went on in the human body.

Of course Jivaka was no ordinary mortal. He was born of the "Mango Flower," most beautiful of women. The "Mango Flower" appeared upon a tree among the other flowers, after millions of years of budding and rebudding—which is not an unbeautiful concept of the evolutionary theory! At any rate, there was born to her a truly prodigious child, in that he held in his hand a little bag that was found to contain the acupuncture needles of the surgeon. And the people rejoiced since it seemed that, at last, the "king-physician" had come to the earth. With such a supernatural start, Jivaka had a fairly simple time of it.

The careful descriptions, however, of the difficult operations this wonder man was called upon to perform cannot be dismissed with a shrug and a smile. The writers of the legend were too well acquainted with their subjects to have fabricated them. Doubtless they stretched their imaginations in so far as Jivaka and his revealing baton were concerned, and it may have been merely a symbolized tribute to his diagnostic skill. Nevertheless, there is the tale of a man who suffered from twisted intestines. He called upon Jivaka, who diagnosed a condition of volvulus. And the description of the operation shows the great Jivaka untangling the intestines and putting them back into normal place. There is still another legend, concerning a youth who fell while attempting amateur acrobatics—as boys will—upon the limb of a tree. Again Jivaka used his magic sticks to look within the body and found that the boy had suffered a misplaced liver. He operated, and restored the organ to its former residence.

There are dozens of other accounts of difficult surgical feats on the part of this legendary hero. All of which cause us to go a bit slowly in boasting of modern progress and make it difficult to set a time at which important surgical efforts had their beginning. We do know that reasons for operations have gone unchanged through

the ages. Men have needed surgery for three fundamental reasons: the relief of inflamed tissue, the removal of abnormal growth, and structural and plastic reconstruction.

Inflammations seem to have been taken care of, in one way or another, from time immemorial. Treatment in some form is, seemingly, as old as the first irritation, the first infection or the first wound. Primitive man probably turned first to Nature and used a thorn for his needle, a prospect suggested by the fact that the aboriginal Dyaks of Borneo to-day use long brush thorns to deal with ulcers, boils and pus-containing sores.

In its methods of healing, early surgery had this in its favor: it was quite divorced from the magic that held back the progress of materia medica. Wounds lent themselves to no magic response, as did a headache or a nervous condition. A wound was a very real condition; so was an abscess. Incantations, prayers, and flim-flammeries did not hasten healing. Magic was called upon to meet some such problem as stopping of the flow of blood but, like iustice, it always appeared with a bandage.

Surgery would probably have made much greater progress, had not ancient religions forbidden the opening of the human body, even after death. Even in the Middle Ages, the priests were still clamping down their censorship on the shedding of blood, and to the pious this became sacrilege. Shylock's epic "pound of flesh" was magnified by Shakespeare into the most gruesome penalty it was possible to exact. To-day stout ladies gladly resign many pounds and are willing to pay well for its removal.

There were two problems, however, which almost from the beginning of time had challenged the skill of all peoples alike: Birth and War. Birth had been a most mysterious and perplexing phenomenon to early man. He built his primitive altars to the enigma of its spiritual significance.

He honored fertility in his religions, his tribal codes and his holidays. Birth and rebirth were wonders that he saw throughout Nature. Spring, with its budding blossoms and its sprouting shoots, the chirp of mating birds and the ardent frolics of faunal life, represented to him the creative forces of Nature, and he felt himself kin to the cosmic urge, so that his springtime games and ceremonies were expressions of the awakening of creative impulses within him.

The Maypole dance, so naïvely engaged in by our children, is a relic of an ancient ceremonial dedicated to the idea of reproduction.

Yet, so far as birth itself was concerned, little or nothing was done to improve the method of its accomplishment or to ease the travail of the mother. In the beginning, women may have delivered themselves of their children almost as easily as animals. We still hear tales of peasant women of many lands who start for the fields in the morning and return at night with their offspring. Labor to them has been little more than an interruption in the day's toil. But even at the time that man was first beginning to express himself in terms of carved figures and symbols, birth difficulties had already overtaken womankind, for there are pictures in the early Egyptian and Greek carvings which have been interpreted as representing obstetrical chairs. There are other scenes illustrated, showing various positions taken by women, when in the obstetrical chair, to make their ordeal as comfortable as possible. And there are references to these chairs in the Bible, and the midwife is frequently mentioned in all early holy books and literatures. Midwives seem to have been among the world's earliest servants. But there is relatively little value in the early records concerning midwifery. Despite its universal occurrence, it was held taboo. It was woman's secret. Husbands were supposed to know nothing. In mid-Victorian dramas the father was kept unaware of his impending paternity until he heard the rustling of the stork's wings. Audiences were expected to believe this.

And so, midwives had this field pretty much to themselves over countless centuries. And if there be one instance where biting criticism can be directed at woman as a professional figure, this is it. Amazing and incredible though it seem, women completely failed to take any step that would aid their fellow women and themselves at this crucial event. In all the thousands of years during which agony and death were observed in a thousand ways, no woman invented or contrived any method or instrument intended to lessen the pain attendant to childbirth, or to make it a safer experience. It was only when man came into the field that inventive minds sprung into action and obstetrical progress began. It may be that the very timelessness of their task inured women to their ancient methods, and that men looked more sensitively upon the

scene, coming to it with fresher eyes—the eyes of an opposite sex, looking compassionately upon Nature's most fundamental, yet often cruel, expression.

Yet, strange to say, man's place at the bedside of maternity is a matter of but a comparatively short time. It was in the eighteenth century, to be exact, that men were officially accepted as obstetrical assistants and allowed within the mysterious and secret doorways of the chamber of labor.

The story of midwifery varies but little. It goes monotonously along from a period thousands of years before the Christian era almost to the portals of our own day. It deviates from its monotonous course only in the personalities of the midwives themselves. There were periods in and about the Middle Ages when the midwife became a more or less disreputable, and not uncolorful, figure. She wandered about the small towns, putting in at taverns, bibbling too much and leading a nomadic gypsy life. She was careless, often wanton, and resorted to charlatanry. She had charms to sell and spells to cast. For a sum she would withhold a curse and give a blessing; she could brew herbs and insure you a male child with the aid of incantations and mumblings that didn't always work. In the period of the Renaissance, with wandering "vagabond" surgeons and midwives abroad, the prospective mother had an excellent chance to be butchered to death, rather than delivered. There are reasons to believe that the male "barber" and "vagabond" surgeons did get to attend some confinement cases, thanks to the fact that they wandered into small communities where, mayhap, they were taken home by husbands casually met over the tavern cups. As a rule, however, only midwives were used.

About this time, particularly in the sheep-raising sections of Germany, the fact that a man had some experience in attending his ewes qualified him to go forth to attend women in labor. So much death and trouble resulted, however, that a law against this practice was passed in 1580. For many years, it was not uncommon for sow-gelders to be called in to perform the Cæsarean section.

In this connection it is interesting to note that the Cæsarean section, which, to this day, is classified as an operative measure of importance, is as old as mythology. Not only is it mentioned in the Bible, not only do the Egyptian carvings indicate its existence

several thousand years before Christ, but it is part of the warp and woof of the ancient Greek myths. Thus, Dionysus is shown born of what appears to have been a Cæsarean on his mother, Semele, and, so the fable goes, was transplanted into the body of his father Zeus for nourishment when the mother expired.

The arrival on the scene of the male practitioner proved at first somewhat calamitous. For the midwives had closely guarded their secrets, and were not ready to give them up to this new competition. It was, so far as the male surgeon was concerned, a slow process of breaking down old reserves and building up new confidences. Royalty, from the almost constant presence of court physicians, had become accustomed to having a little medico in their castles, and since the kings had a mistress for each mood, and not infrequently these mistresses presented their royal highnesses with children, it was in the chambers of one of the regal lights of love that the barrier was first broken down. In France La Vallière, mistress of Louis XIV, allowed a male obstetrician to enter her lying-in chamber, at the request of the frivolous Louis. Though in England Queen Henrietta Maria had already given royal sanction to this new custom. Thereafter many ladies of title took up the fad, which rapidly spread and finally reached the masses. But the male midwife had no path of roses. A vogue may be a fashion, but that does not make it a habit, and the presence of a midwife had become so established a custom that it was not easily ousted. These women attendants were quick to make use of the natural fears of their patients, particularly when the bungling methods of these early obstetricians resulted in any deaths. Thus, when Princess Charlotte of England died under the care of two male court surgeons, a midwife was called in to deliver the baby destined to become the great Queen Victoria. Even Napoleon took no chances, though he had great faith in his own personal doctors, and allowed a surgeon to be present only as an assistant to a midwife when Marie Louise was in labor.

It soon became apparent that something was wrong with the manner in which men handled these cases. In spite of all the technical knowledge they built up, in spite of all the improvements they seemed to make in the manner of delivery, their patients continued to die at an alarming rate from puerperal sepsis, or childbed

fever. Statistics showed that midwives were eminently more successful. Puzzled though they may have been, their stubborn self-deception blinded the medical men to their difficulty, though to-day the answer is so astonishingly simple that their stupidity seems almost incredible. We have merely to remember that these men came directly to the maternity bed from contact with other patients; that many of them rushed from a laboratory where they had spent the afternoon making post-mortem dissections of germ-filled bodies —and not one of them had made the slightest effort at cleanliness.

Antiseptics, you must remember, were unknown and it is doubtful if any of them so much as used soap and water. It would have been nothing short of miraculous, therefore, had their innocent victims escaped infection. Yet, even when the reason for their difficulties was hinted, and finally shouted at them, the army of stand-patters merely became angered and reproachful. And, doing nothing about it, their mortality rate swelled. So serious at one time was the condition that a prominent writer openly declared that one might as well deliver a woman to the guillotine as to the bed of confinement. Then came our own Oliver Wendell Holmes, whom we are far more accustomed to associating with philosophic essays than with obstetrics. Holmes had been a professor at the Harvard Medical School. Being a philosopher, as well as a man of medicine, he tried to apply logic to this serious situation. One day, he made a suggestion to the physicians of the world, that perhaps they were killing their patients with their own hands. His remark created nothing short of an explosion. College professors and medical men alike leaped upon his words, branding them as utterly ridiculous and placing the blame on Providence, who has always had to carry the burdens of blundering man. This was in 1843. Three years later, in Vienna, a young fellow, with the comic-strip name of Ignatz Semmelweiss, who not only had read Dr. Holmes's papers with interest but was willing to give the benefit of doubt to the American visionary, ordered a bowl of chlorine water to be placed at the doorway of the maternity ward in the General Hospital, in Vienna, and insisted that all who entered be compelled to wash their hands in it. For about two years, he kept a record and found that the death rate had been considerably reduced. Where five hundred patients had died in one year, only fifty had now suc-

cumbed, and most of these with complications that might explain their decease at this crude period of obstetrical knowledge. He published his facts and issued his plea for sanitation but, as before, it fell upon either deaf or indignant ears.

For nearly ten years the medical fogies were still clinging to their dirty habits, and the list of dying mothers began to multiply. It is stated that in the University of Jena every case of pregnancy ended in death.

Semmelweiss brooded over this terrible situation, taking it so much to heart that he lost his reason, and he was to be seen in the streets, disheveled and threadbare, preaching from soap-boxes to the passers-by. He was like an apostle, talking and beseeching that cleanliness is next to godliness, but the women who heard him merely snickered and sneered, though they themselves might have been walking in the shadow of inevitable death. Finally, he was taken to a madhouse as a disturbing lunatic. It was not until Pasteur had shown the nature of infection and Lister had proven his theory of antisepsis that the blind world was willing to see.

Joseph Lister, who more than any one else—unless it be Pasteur and Koch, that arch-enemy of wound infection—was responsible for the introduction of the death-cheating blessing of antisepsis, was an English surgeon attached to the Edinburgh Infirmary. He was the last of a picturesque line of Quaker physicians. His father had taken up the new fad of microscopy, and the young man, who was destined to be knighted for his gift to humanity, made a plaything of lenses in microscopic peerings. When, years later, at the University of London, he undertook research work, he was well equipped for his task. He was attached to the hospital staff, and as he was endowed with the most kindly and sensitive of natures, he was appalled by the high mortality rate following operative measures. The Quaker's natural love of humanity was deeply rooted in him. He made up his mind to do something about it. Looking about, he noticed that the methods for keeping a wound clean were limited to a silver suture and a frequent change of dressings. It so happened that he had personally been called upon to perform a number of amputations in which gangrene had caused the death of the patient. Mortification, he saw, was at the base of this deadly agency. One day, quite by accident, his attention

was called to the work Pasteur had been doing to prevent putrefactive agencies from infecting wounds. He first tried Pasteur's method of heat sterilization, and when this proved unsuccessful, he began to experiment with chemicals. He tried one thing and another without great success and, purely by process of elimination, came upon carbolic acid. That was the beginning of his victory, although to-day his agency is looked upon as being a bit too severe and bichloride of mercury or iodine is preferred. It seems that the first test of a worthy contribution to science is that it receives the disfavor of the world. Just so, Lister found himself derided by most of the medical profession, but, quite undisturbed, he went on perfecting his dressings. Carbolic acid became the panacea of the day. Not only was it applied as a dressing to wounds, not only were parts of the body prepared for operation by being cleansed in this germicidal chemical, but it was sprayed into the atmosphere until the operating room fairly reeked with it. Up to this time, amusingly enough, Lister had not yet learned the secret of washing the surgeon's hands. He had given antisepsis to the world, but not asepsis. That came a little later. Nevertheless, mortality from infection decreased considerably and Lister's discovery was acclaimed and laurels of praise were placed upon his brow. It must be said in deference to Lister's generosity and sense of fair play, that when the story of the ill-fated Ignatz Semmelweiss was brought to his attention, he, with utmost self-resignation, announced that the glory of the discovery really belonged to the Austrian and that he insisted upon passing his laurels on.

The development of antisepsis was a great boon to midwifery. A child was now able to come into the world clean. But its passageway into this vale of tears was frequently a passage beset with devastating obstacles.

And so we come to a strange and almost fictional family—the Chamberlens. For generations members of this clan had attended the bedsides of royalty and plebeians alike. For two centuries individuals of this line operated, and for two centuries they kept a secret; this secret had to do with certain instruments they had perfected and which we to-day know as forceps. The male members of their family, of whom Hugh and Peter became best known, learned the secrets of midwifery from their sisters. Thanks to the mystery

that surrounded their particular method of delivery, their names were whispered about and Hugh made his way into the very presence of Queen Anne. Selfishly guarding their secret, they allowed the public at large no inkling of how they operated, and through this unethical selfishness cheated the progressive world out of a great improvement over an old method. Generation after generation, they passed their invention from father to son, and although innumerable scientists tried to fathom it, they were unsuccessful. Finally, Hugh, suddenly finding himself financially embarrassed in Paris, offered to sell the family secret to an eminent Frenchman for ten thousand dollars. The Frenchman demanded a test and selected a case where the pregnant woman suffered from a deformed child in her womb. The operation failed and the offer was withdrawn. Notoriety attached to the Chamberlen case did widespread harm. Charlatans appeared at every side with announcements that they had solved the riddle. Every kind of fake was perpetrated. Finally, the University of Amsterdam induced Hugh to sell it the invention, which the heads of the college then proceeded to continue as a secret. Outraged at this action, a number of citizens of the city declared that if the method really had its boasted efficacy, it should be made known to all the world. They sent two spies to the school in the guise of students, and these brought back the report of the obstetrical forceps. Yet it would seem that some trick had been played either by Chamberlen or by the University, for the forceps described by these public agents mentioned only a single prong, and it was not until Peter Chamberlen had died that the real instruments were revealed. For four pairs had been hidden away in an old trunk. These instruments, which have since been considerably improved, are made to conform with the shape of the female pelvis and to assist the birth of a child where the forces of the mother have been exhausted. To-day, we consider childbirth one of the necessary discomforts of existence. We look forward to it with no apprehension. Mothers are examined with a view to their fitness for having children, or else steps are taken to insure a successful, if unnatural, culmination of the birth process. The death of a mother or child is an exceptional thing in a civilized community. Accidents will happen. But we are glad to say that they are very rare.

With the development of modern anæsthesia, the pains that only a woman knows have been rendered quite tolerable, but we leave this phase of the subject for another chapter and proceed with our story.

War was Hell long before Sherman came to his terse conviction. But then Hell itself is relative. The scope of its panoramic inferno has been infinitely enlarged by what we are pleased and proud to call the progress and development of the instruments of war. Whether the issue was fought out in the aboriginal forests with the most primitive of weapons, or with no weapons at all, by men who knew no better; or whether its fiery breath was cycloned over the poppy-clad slopes of France with bomb and Bertha, with gas and grenade, by men who should have known better—curiously enough, it was war that, in spite of its brutality, wakened the most merciful and humanitarian impulses in man's nature. And wherever humanity nurses the gruesome consequences of God's erring children, there you will always find the Doctor, playing the part of the most self-sacrificing agent of Providence.

So was the battlefield the first laboratory of the surgeon. Hippocrates himself called the battlefield the surgeon's school.

In times of peace, the human body was a book that presented only its cover to the inquisitive eyes of the medical man. The battle-ax and cutlass, dirk and dagger, sword and saber, gave him his only opportunity to glimpse the material contents of the house of man. It was on the field of Mars that wounds of every description called for their treatment and repair. And it was here that the earliest anatomical studies were made and the first scientific progress recorded.

In the beginning, when primitive man applied the law of the survival of the fittest in its narrowest sense, it is not likely that much attention was paid to those who fell by the wayside. Perhaps when tribal loyalty was created, the day came when a survivor carried his less fortunate comrade into the sheltered safety of a cave and there applied cooling leaves and grasses to his hurts. At any rate, those scientists who came upon the Java man, that ancient brother of the stone age, found indications that some sort of operation had been performed on an injured hand. And there were those tens of thousands of skulls which, as we have mentioned

at the beginning of the story, testify to the ability of our prehistoric forbears in the difficult operation of trepanning.

But civilization advanced. Man learned to fashion implements of copper and iron, and to temper steel. And even as he used these metals to kill, he also used them to cure. With one knife he would slay his fellow; and with another, restore him to comfort and capability.

When Homer smote his lyre and sang of the deeds of valor in the Trojan war, legends told tales of the wonder-work of surgeons. They were given acclaim equal to the greatest of heroes, and were dignified to the place of associating with the gods. Homer himself sang their praises, selecting in particular Machaon and Podalaius, both sons of Æsculapius. It is related in Homer that Podalaius was the first to abstract blood as a means of combating inflammation. He was given in marriage to the daughter of the King of Caria, as a reward for opening a vein in her arm when she fell ill. In Homer, too, we read the story of the wounding of Menelaus, who is best known as the husband of Helen of Troy. Machaon, called to attend him, found an arrow piercing the king's side. The operation, said Homer, consisted of removing the arrow, sucking out the blood, washing the wound and making a healing plaster of plant juices. The picture is perhaps a fairly accurate one of the methods used over a considerable period of time. Greek mythology asks us to believe that the surgical art began with Chiron, the centaur, who was presumed to have taught the mythological Æsculapius, but most peoples have a similar hero in their myths, and legendary statistics are against the Greek claim of priority.

It is logical to suppose that the instinct of protection taught the primitive man to invent a barrier against the weapons of his enemy. The whole history of warfare is the history of a contest between weapon and defense, between projectile and armor. From the wooden shields of the savage to the glittering phalanxes of the Greeks and Romans, armor was essential because in those days a wound of any severity invariably meant death. In ancient days, the trails were wearisome and long, and a wounded man was an impediment to the object of the march, so that it was an expedient thing to kill him and leave him for carrion. Only the great leaders were given surgical assistance.

One is reminded of the story of the cowboy who married his school teacher. He had known only horses. Returning home from the honeymoon without his bride, he stated that she had broken her leg and he had had to shoot her. So in the gladiatorial combats. When a man fell and did not rise again, very little attention was paid to his wound, but "thumbs down" from the Emperor ended his agonies there and then. He was not taken home and nursed back to health and permitted to syndicate his reminiscences. In the modern student duels in German universities, a doctor is always in attendance, and the saber slash is followed by immediate antisepsis and suture. But in Rome the life of the wounded man was help cheap and very little opportunity was given to surgeons to advance in their knowledge of the treatment of wounds. It must be said in deference to the religious ban on surgery that it could not have been an arbitrary interdiction. Experience must have taught that a cut body was little better than a dead body and that the consequences of surgical operations tended to raise the mortality rate. On the other hand, the old church thrived through death. A disembodied spirit, sent blessedly on its heavenly pilgrimage, could not resent the seizure of its lands. At any rate, the Dark Ages contributed practically nothing to the development of the kindest cut of all. During the Holy Wars, there was no need for surgery. Rapine and slaughter and desolation by fire spared no life that was tinged with heresy; the zealot died gladly for his Cause and rejected any aid that might be given to deprive him of his seat in Heaven.

The great change came with the Renaissance and the invention of gunpowder. For here was a missile that could penetrate the armor and rendered it obsolete. When, at the battle of Crécy in 1346, the boom of cannon was heard for the first time in history, surgeons found themselves completely at a loss in attempting to attend the thousands who were dying from the gangrenous after effects that came with the loss of limbs. When the wounded survived, the stumps were bound in splints, and crutches appeared for the first time. A picture made about 1400 shows the first artificial iron hand. And it is recorded that Goetz von Berlichingen, having lost his right hand through a musket shot, arranged for the manu-

facture of half a dozen hands, which he carried about him because each was flexible at a given joint.

More modern methods of attending the wounded slowly began to make their appearance. In 1487, Queen Isabella of Spain introduced primitive ambulances and field hospitals during the siege of Malaga and, although it had been the custom for army surgeons to be in attendance only upon the nobles and chieftains who were their patrons, there came out of the French provinces a young man who was to give the buck private his proper attention and thus to endear himself through all time to the underdog and overlord alike. This man was Ambroise Paré. In 1532, when Paré was leaving his French countryside to go to Paris for a medical education, the battlefield surgeons were still scratching their heads trying to figure out the nature of the injury inflicted by gunpowder. They had decided that it was a deadly poison and that it could be treated only through the application of boiling oil of elder. It had long been the custom, where the amputation of a member was necessary, to apply red-hot irons, burning bits of pitch-wood, molten metal or hot oil. The use of the ligature, or tying of an artery, had been gradually improved, but it had never been used in an amputation. The torture of the unfortunate victim can scarcely be imagined. That is, not until Paré brought his soothing anodyne to the battlefield.

Paré's entrance upon the scene was not a particularly imposing one. He was a typical bumpkin, zestful for learning but handicapped by his lack of background. When he appeared at the French university, he was snubbed by his fellow students and laughed at as a yokel because he could write his papers only in his native dialect. A very sensitive youth, he felt keenly these jeers but managed to tolerate them until he had finished attending the lectures at the Faculty of Medicine. At first, he occupied himself as assistant to one of the barber surgeons, who at the time were practicing their charlatanry over France. This was a crucial point in the careers of these barber surgeons: the government was harassing them on one hand; the honest members of the medical fraternity were trying to oust them on the other. The surgeons had become divided into two classifications: "barbers of the short gown" and "barbers of the long gown." The former attended to minor blood-

lettings on the more apoplectic members of the holy order, despite the fact that the Church was extremely antagonistic to any form of surgery and labeled it a practice for Jews, heathens and the vulgar in general; the latter attended more important cases.

The Church was well rooted in the background of the times in which Paré rose to the status of the world's greatest army surgeon and the originator of modern methods of surgery. He had worked for a time after leaving the university as a dresser in a hospital, and after three years of post-mortem experience found himself at the age of nineteen completely convinced that he had gone rather far—a not unusual state of mind for young men of those years. Since his country was engaged in a number of military difficulties at the time and since the country lad was still burning under the snubs of his college fellows, Paré attached himself as body surgeon to Marshal Monte Jan, and accompanied him with the army of Francis I in the invasion of Provence. Once upon the playground of Mars, Paré soon learned that he had to make a new personal inventory. Much of the learning upon which he had prided himself meant little in the face of difficulties with which he had never before come in contact. Thus, one night he learned to his horror that, thanks to a long siege, the supply of boiling oil for gunshot wounds had run out. There was no way of getting any more and the wounded kept coming in demanding treatment. He spent a sleepless night, terrified at the consequences that he felt were certain to follow. Surely these men would die unless the oil was applied! Sunup found him distractedly pacing the front of his tent. He was helpless, and since there was nothing he could do he fell back on a series of ordinary healing lotions. To his amazement, the men did not die; on the contrary, they seemed to fare a great deal better than others who had been given the more extreme treatment. Furthermore, the absence of the torturing methods seemed to give them new strength. This set young Paré to thinking. He suddenly recalled a secret salve that had been used effectively by a surgeon in Turin with whom he had come in contact. He determined to learn what it was. Intermittently over a period of two years, when he was able to leave the war zone, he took steps to gain the confidence of this doctor and finally was able to buy his secret for a fair price on promise that it would not be revealed. Ludicrous

as it may sound to-day, this carefully guarded secret turned out to be oil of puppy dogs—a sort of lard-like composition made from stewing up young puppies. Its efficacy, however, had given the good doctor of Turin such a reputation that Paré decided the world should know about it and betrayed the confidence of the inventor. Supplied with this strange panacea, he returned to the war zone and began applying it to gunshot wounds with such excellent results that Paré's puppy dog oil became known far and wide and has, in fact, come down in history. Certainly he was the idol of the army. This position in the eyes of the fighters was first gained when he defied the very highest surgical authorities who had learned that he changed the old methods. They commanded him to return to them. Whereupon he flatly refused, taking his stand against the giving of unnecessary pain to the wounded. This was a tenet for which he fought during the remainder of his life. An instance of his popularity is revealed in an anecdote which relates that on one occasion, tired of war duty, he took on a disguise and went to Metz for a holiday. Some soldiers on leave recognized him, called to their fellows and soon a young regiment was carrying him through the streets singing and shouting his praise.

His contribution to science, however, did not end with tearing down the old brutal systems of treatment and replacing them with simple remedies. He also proved that, instead of using red-hot irons on the amputated leg of a man, it was possible to stop the bloodshed by the more merciful and scientific use of the ligature. For some time he had felt that the tying of the bleeding artery could be achieved. But a bit fearful of his own judgment he conferred with a number of surgeons in Paris. "We agreed to make a trial on the first case that offered itself," Paré relates in his writings, "but of course we had the usual cauteries in case that our methods failed." It so befell that a short time later a shell penetrated the tent of M. de Rohan, hitting that worthy in the leg and necessitating an amputation. Therewith was made the historical experiment which introduced a highly important operative innovation to the world. The invention of the ligature by the tying of a bleeding vessel was one of the most important advances in surgery. The principles of surgery are concerned with the following

procedures: incision, excision, control of hemorrhage, protection of tissues, prevention of infection, suture and the hygienic principles that govern convalescence in general. In modern surgery, hemorrhage is insignificant. Vessels are tied before they are cut and post-operative anæmia is practically never encountered. It was Paré who was the first to teach the world the control of hemorrhage.

As a practical battlefield surgeon, Paré was without a peer. It is said that he was able to amputate a limb, even a leg at the hip-joint, in a few sweeps of his blade, and in less than a few minutes completed the operation, crying "Voilà!" as he held the severed member on high. His speed was astounding and served to minimize the shock. Combining the use of the ligature with his surgical skill, he saved many lives.

Paré's activities, however, did not end on the battlefield. He did peace-time service that won him the friendship of four kings, a circumstance which, according to legend, caused him to be the only Protestant to be spared in the historic St. Bartholomew's massacre. Kingly intervention is credited with saving him. His attitude on religion was brought to light shortly after when Catherine de' Medici, commenting on his Protestantism, asked him if he expected to be able to enter the next world. "Yes," immediately responded Paré, "because the merciful God knows all languages and will understand mine as well as yours."

Weary of warfare and almost sickened by the pain and torture he had witnessed, Paré in his old age became a rabid pacifist. He had made his share of worldly goods and was able to live comfortably despite the peculiar arrangement the government made with its surgeons. There was no fixed salary, nor was there any organized medical corps. One had to depend upon the soldiers themselves for such fees as they might care to pay. Thus, one might give him a horse, another a cask of wine and a third a bag of gold. From the accumulation of all such diversified contributions, Paré found himself comfortably well off in his declining years. He applied himself chiefly to laboratory research, and was among the first to stipulate that an affinity existed between infection and contagion. Infection had been a common visitor in the battlefield tents and contagion he became conversant with during an

epidemic of measles. He argued that both should be rigorously guarded against.

The other nations were quick to follow Paré's leadership. In Germany, the baggage train made its appearance, traveling under canvas and forming a sort of a covered-wagon variation of our own modern ambulance corps. It was at this time, that those war-time daughters of delight, the camp-followers, were pressed into service, for purposes other than after-battle diversion. They were, perhaps, the first of the battlefield nurses, for the Germans insisted that when they were not plying their oldest profession, they should be attending the wounded. Maximilian I insisted on sanitary regulations and began to perfect a real military organization, founding the present medical regulations of the German army. Also, a decree of Coligny demanded that a surgeon accompany each infantry troop. The Duke of Guise, when beleaguered at Salignac, isolated cases of communicable disease and made hospital arrangements for sick and wounded. When, at the raising of the siege, the Duke of Guise and the Duke of Alva got together in an agreement that their wounded enemies and prisoners should not be massacred, as had generally been the custom, the first step toward the modern Red Cross idea was taken. This idea was perfected two centuries later. It was about 1743, during the French and English wars, that Sir John Pringle, a Scotch surgeon, and the Earl of Stair, got together and conceived the idea that the wounded should be protected from the attack of the enemy. Both these men had laid the foundation for this noble idea through long years of experience in the army prisons, public jails and government institutions, which were conducted in the most slovenly and disgraceful manner. Then, too, both had been eyewitnesses to disgraceful treatment of men who lay wounded and helpless.

"But," writes Sir John, "the Earl of Stair, my illustrious patron, being sensible of the hardship when the army was camped at Aschaffenburg, proposed to the Duke of Noiess, of whose humanity he was well assured, that hospitals on both sides should be considered as sanctuary for the sick, and should be mutually protected. This was readily agreed to by the French general, who took the first opportunity to show a particular regard for this suggestion." Thus was born the Red Cross idea. Sad to relate, it

was not so generously applied for a number of years, but in 1864, at a conference in Geneva, it was given final sanction.

It is amazing what the human animal will suffer without revolting. Such humane modern methods as we know came only after the usual battle against established custom. Men would have gone blindly along, taking what they got and asking no questions. Only the interference of a truly remarkable woman changed the history of battlefield treatment. This woman was Florence Nightingale, an angel of mercy if ever one came upon this earth!

Which takes us back for a moment to a German preacher, named Theodor Fliedner, whose parish was a tiny hamlet on the Rhine. The Rev. Fliedner, a reformer at heart, had the not unfamiliar notion that he could bring to grace fallen women whose sins had led them to prison cells. He urged prison officials to turn jailed women over to him and he would offer them asylum in a large greenhouse on his grounds. If, he argued, their maternal instincts could be aroused and their interest in society restored, they could be made into useful citizens. Thus, upon the land of this good social worker, was born the first training school for nurses, in the sense that we know such an institution to-day. From an experiment in prison reform, it gradually grew into an institution where women from all walks of life were instructed in attending the sick and ended as a school for deaconesses.

To this school came Florence Nightingale, a young Englishwoman who was bent upon dedicating her life to human ministration. Here she received her training and set forth to develop the art of nursing and raise its standard in her mother country. Her efforts in this connection aroused the attention of a few philanthropic public figures. The Crimean War gave her the opportunity of leading her idealistic crusade. In 1854 a general call went out for women to go to the front in the rôle of nurses. And, even as in the late struggle, the call was answered by women of all classes. Lord Sidney Herbert, the Secretary for War, had heard of Florence Nightingale's work and asked her if she would accompany a nursing group and give the battlefield conditions her personal supervision. Hardly had she arrived, when the slovenly nature of the field hospitals and the treatment of the soldiers shocked her into action. She immediately demanded better quarters for the men and better

rations. Reforms were needed all along the line, she reported to headquarters in England. Sanitation, in particular, was terrible. The men were improperly housed; the wounded and the well were not fed properly; filth abounded and disease was responsible for as many casualties as guns and sabers, she reported.

Her demands were met with the customary lethargic indifference and polite opposition of comfortable office holders, who went through the usual motions of dodging the issues, while spouting moralistic and patriotic platitudes. She took her case to Lord Raglan, whose humanitarian interest she aroused, and he gave her immediate personal aid, at the same time launching agencies for the raising of funds. Within three months she was providing decent clothing for some 10,000 men, had opened a supply depot on her own hook—since the government had failed to respond—and was feeding a thousand men in a diet kitchen. Single-handed, she had won a great victory for mankind.

Soon she was bringing fresh air and general cleanliness into the field hospitals; sanitary measures were being applied and squads of nurses were being organized to carry out her carefully organized plans.

Thereafter, the quality of mercy grew less strained in war-time. The first major improvements were in hospital service and in the building up of methods for getting the wounded off the field as rapidly as possible. The late war saw this system operating with an almost miraculous efficiency. Thus began our modern ambulance system, and thus the codes of warfare respect the Red Cross flag even as the flag of truce.

But wars are not always with us, fortunately, and when the surgeons came home with their vast stores of new-gained knowledge, they were able to apply it to the needs of peace. Generally speaking, surgical advance was pathetically slow and not vastly exciting. Like most other knowledge, it was transported from one point of the compass to another by wanderers and travelers. It is an instinct that runs through life for all animals to try to rid themselves of bothersome things. Thus a cow swishes its tail to keep away the flies, a dog limps on three legs when the fourth has been injured, a horse perfects a sort of shimmy to toss off the troublesome insects and man learned to sharpen his blades to remove

ulcers, abcesses, tumors and such growths as came to his attention.

One of the most hygienic of operations that grew out of the customs of war was that of circumcision. Its usage as part of religious ritual began with Abraham, but its inception dates back to a most barbaric practice. In early Egypt, defeat was linked with effeminacy. To be vanquished was to be associated with weaklings and women. The victor was not content merely with the spoils, but felt that he had to carry home some trophy that marked his valor, and at the same time reduced his enemy to an approximation of the feminine. Thus, once his opponent was down, the conquerer would remove the conquered one's genitals with a sweep of his sword and carry them back to demonstrate that, like the Royal Mounted Police of the Northwest, he had "got his man." Such trophies have changed styles from time to time: the Indian, with considerable dexterity, removed the human scalp; the head-hunter of Borneo must toss a bloody cranium upon his beloved's doorstep before he can go courting, and other tribes have demanded fingers, hands, and other parts of the anatomy as tokens of their prowess.

Since the severed phallus left no doubt of the sex of the victim, it was looked upon as conferring upon its possessor a particular claim to skill and bravery. In later generations, this custom was modified when the eunuch system was adopted by potentates who did not wish their harems to be shared by men whose vitality might prove competitive.

As the centuries passed, victorious warriors began to see an economic use for their captured enemies, the violent practice went out of style and prisoners became slaves. To mark these serfs, the original operation was now changed to castration, but ignorance of sound surgical methods caused so many victims of this practice to bleed to death, that it was finally abolished. The idea of keeping one's prisoners sterile still flourished, however, and the next measure adopted was that of severing the procreative gland. After all, we have not completely divorced ourselves from the general ideology that prompted such a procedure. To this day, we reward our soldiers with medals and trophies if they have been able to kill a sufficient number of opponents, and our grandfathers brought home from the Civil War locks of hair and pieces of clothing to prove they had been at the battlefront and killed their quota.

The transition from this practice to the adoption of circumcision necessitates an attempt at comprehending their deductive reasoning. The practice of circumcision was, according to the annals of legend, adopted by Abraham in Chaldea to mark in infancy the members of his race. It is to be remembered that they had no birth certificates and the fashionable footprints of the Bertillon system were not even dreamed of. Furthermore, in adult life, men were apt to wander in those nomadic days, and the Jews were insistent upon claiming their own for their own. Moses, realizing the hygienic value of the practice, incorporated it in the ritual. According to other authorities, and especially mentioned in the Ebers papyrus, the Egyptians had practiced circumcision not only upon boys but upon girls when they arrived at puberty. The method has been engraved in stone.

The subject is interesting in that it points to the very beginnings of surgery, arising, as medicine did, from tribal fetishes and religious rites.

The Talmud informs us that the early rabbis knew how to suture wounds.

Furthermore, they freshened the edges of old wounds and made artificial legs and artificial teeth. The ancient Egyptian mummies also show that dentistry, in a primitive form, was known to them. A number of these mummies have artificial wooden teeth, wooden legs and arms, and splints about fractures are not uncommon. The early Irish made artificial hands of silver and other metals. In India, as early as 1000 B.C. the Susruta and Charaks were laying down rules for surgical methods. They were advising the surgeon to be quick of hand and of unflinching courage; they were warning him to work as rapidly as possible that his patient be spared pain. And thus encouraged by the Holy Book, the young students were given a most rigorous training in skillful manipulation of instruments. Since they could not practice on human bodies, they learned to make swift and sure incisions by experimenting on such vegetables as squash or melons. They had a large assortment of surgical instruments, many of which were made to resemble animals; the lion's mouth and the heron's bill being the favorite shape for forceps to extract foreign bodies. They also used magnets for extracting metals from the eyeball. Back in the legendary days of Homer,

it appears that Greek women of high social standing were educated as nurses. Hippocrates mentions them frequently and their presence in the chamber of the sick was ever a tribute to their self-sacrifice. Captive slaves were frequently educated as nurses and the great Sardanapalus, King of Assyria, who reigned about 670 B.C., was nursed by his slave girl when every one else had deserted the king in his hour of trial.

Within recent years, archæology has awakened from its long slumbers, and while a number of scientists were harnessing the air as a medium of expression, sending sound and form with infinite speed over magical distances, or riding it in defiance of all the rules of gravitation, others were digging into the ground and unearthing the mysteries of ancient civilizations. Egypt and Cathay have been fertile fields of information and the splendor of olden times has been a challenge to modern artisans. But perhaps nothing has yet been dug from the earth that throws so interesting a light upon the character of ancient culture as the so-called Surgeons' House found in Pompeii. Their operating slabs, obstetrical chairs, and various contrivances and paraphernalia for surgical work were found in excellent state of preservation, with perhaps some six hundred well-differentiated instruments. Most of these were fashioned of copper and showed marvelous skill in their manufacture. These people had hospitals and clinics for the suffering and afflicted.

There are many interesting reflections and observations with regard to surgical measures. Hippocrates implies that specialists were already considered when he states that "lithotomy, or the cutting of stones, should be left to those who make a business of it." The tying of arteries was known, and the same author comments that "if the artery is large, it is necessary to tie it in two places with a bit of silk or cord." Paul of Ægina came upon a bit of original discovery when he saw a slave attempt to cut his throat. He states, "I noticed that neither his jugular vein nor his carotid artery had been severed. I dressed his wound and it healed. I therefore feel authorized in saying that an incision of the windpipe is possible without danger." This operation, of tracheotomy, now rendered obsolete by the discovery of antitoxin, was one frequently practiced a generation ago when the diphtheritic membrane made laryngeal breathing impossible. There are many people to-day who bear the

old scar of this life-saving procedure. Cancer was known to the ancients. Both Hippocrates and Paul mention it, and the latter honestly admits: "For my own part, I never cured a case." He warned his fellow surgeons to beware of cancerous conditions. Abdominal tumors were operated on, the method having been to "bind a leaden wire about the root and strangle it; tighten it day by day until the root has been cut through." Recalling the primitive state of anæsthesia, it gives one goose flesh to imagine what intense torture such a process must have brought to a patient. In fact, the suffering of these patients in early days is frequently mentioned and their cries of pain were most distressing. In many instances, the patient would rather succumb to the disease than undergo the ordeal of surgical interference.

The famous Celsus, one of the greatest of the early physicians and a disciple of the famous Alexandrian school, informs us that he and his contemporaries were quite familiar with the ordinary surgical procedure and the knife was frequently used for the cure of disease except in major abdominal operations.

In the light of our modern knowledge, it is not vainglorious to say that their success was much more likely to be accidental than premeditated.

With the coming of the Renaissance, Salerno and Bologna in Italy set the standard for surgical technique. With the beginning of dissection and the study of anatomy, it was to be expected that surgery should make rapid advance. Yet a thumbnail generalization of the state of things in the fourteenth century can be made from the writings of Dr. Guy de Chauliac, a French surgical historian. He speaks of five sects. One, a group that advocated poulticing, seeking to soften inflamed tissue and stating as its maxim, "Lax things are good, hard things are bad." Then there were the followers of Bruno and Theodoric who treated all wounds with wine, saying that "Moist things should be placed near all unsound tissue." Then there was the school of Lanfranc that advocated ointments and plasters, arguing, "Treatment should be gentle and without pain." In the fourth place, we have the military group who used oil and hot irons as we have previously mentioned. Finally, there is reference made to "fool women who refer their sicknesses to a saint."

The life of a surgeon living at this time was not a path of glory

and gain. The itinerant barbers were held in general contempt and frequently stoned, and the man who was devoting his life to the pursuit of surgery from its most scientific standpoint was strenuously opposed by the Church; if he operated, and the patient died, he himself was very likely to be tried and sentenced to death. Surgeons, therefore, feared to undertake any but the simplest operations and they frequently compelled the patient to sign a guarantee that they would not be held responsible in the event of death. This custom is in vogue to-day in hospital wards where no surgical operation is undertaken without the patient's written consent.

The guilds of barber surgeons appeared in France about 1260. Their trail was followed by nomadic midwives and medieval "osteopaths" and "chiropractors" and other charlatans who plied their malpractices and their quackeries in such a way that the entire profession got a tainted reputation.

In 1350, the surgeons of standing found it necessary to take action against the "barbers" and nomads. An agreement was reached whereby the barber surgeons were allowed to perform only minor operations, such as bloodletting and boil lancing. In England, the royal wrath came down upon the meddlers with such telling effect that an organization was born out of which grew the present Royal College of Medicine.

It is an old story that when one school of quacks is in process of dissolution, imitators spring up to take their places. And so traveling bands that became known as "the cutters" and "the incisors" made their appearance in the countrysides. These groups, to give themselves an air of mystery and importance, developed "secret methods" which, however worthless, were passed from one generation to another, until they finally took on the dignity of tradition. Word of mouth advertising of these "secret methods" caused certain clans to gain wide prominence, and in some cases the reputations were not altogether undeserved. Thus the Colot family finds its place in medical histories to this day. Germain Colot, father of his line of nomadic practitioners, was presumed to have an original method for performing lithotomies. Whether or not he did, he was eminently successful and greatly respected. Certain it is, that his skill in plastic surgery was considerable and his family brought the plastic art into no little prominence. Their skill in

taking skin from an arm and grafting it on the human nose was widely praised. There were, however, certain inhuman groups who carried on the most grewsome trade the history of plastic surgery has ever known. They created "monsters," or what we should refer to as museum freaks. Like the early gypsy bands, they stole children and mutilated them, performing ugly plastic operations upon them. Some would be given huge noses and others huge ears; faces would be grotesquely distorted. Gasparo Tagliacozzi, of Bologna, records seeing two boys grafted together at the neck and others joined at the arms and legs. These, the mountebanks would take about for exhibition purposes or sell to the highest bidders. Perhaps this may have been the beginning of the circus sideshow. Monstrosities have drawn crowds through the ages.

Around this practice, Victor Hugo built his grim and terrible story, "The Man Who Laughs," which is the tale of an unfortunate individual who fell into the hands of such a group. His face was fitted into the pattern of an eternal smile, and the tragedies of his heart were submerged beneath the hideously sardonic grimace of his features.

In Italy, plastic surgery was an old art. It had been picked up in India by the early Italian and Portuguese travelers. Its fame was advanced largely by a Sicilian family, who became expert in taking the skin of the face for revamping noses. As early as 1480, bands of roving Italians had carried the plastic methods into Germany. The first practitioner there was one Heinrich von Pfolspeundt, a Bavarian army surgeon, who made artificial noses for his kinsmen after the Hindu method. The Hindus were expert at this art centuries before the Christian era. Thanks to a social custom they had plenty of opportunity for gaining experience. When wives were unfaithful, or suspected of infidelity, it was the practice to disfigure their noses with a knife. It was a matter, seemingly, of cutting her nose to spite your faith. Later efforts to repair these maimed parts gave the Hindus their unusual skill.

When the pious dictums of the Church got to work in Italy, however, during the Middle Ages, plastic surgery, like almost everything else, found the brakes being applied. The good men held up their hands in horror and spoke of such operations as "meddling with the work of the Lord." The particular wrath came down upon the

head of Gasparo Tagliacozzi, who had the misfortune to revive rhinoplasty. His type of work was ridiculed and he faced the abuse, sadly enough, even of Paré, who should have learned tolerance from his own experience. To set a moral example for others, the Church continued to insult the poor fellow even after death. The ecclesiastics ordered his remains disinterred from the grounds of the convent and removed to unconsecrated soil. This warning was not without its effect. It was not until the eighteenth century, that Johann Dieffenbach, who began as a German rifleman, and Karl von Graefe, a young doctor who also struggled in the German war for independence, reintroduced it as an art, and gave to plastic surgery the impetus that sent it progressing to its present state. Von Graefe introduced the operation for correction of cleft palate and improved on the old systems for nose making. Dieffenbach carried the work into transplantation and regeneration of tissues, severed the tendons of the eye muscles for the first time, correcting cross-eyes, and obtained remarkable results in skin-grafting.

To-day, plastic surgery has elevated itself to the level of a supreme art. Entire faces have been rebuilt. Deformed and paralyzed limbs are restored to form and function. Where Nature has been unkind in her æsthetic endowments, plastic surgeons correct her defects and transform the ugly duckling into the graceful swan.

It was not until after the middle of the eighteenth century that there appeared upon the horizon two brothers who were to blaze the trail toward modern advancement: the Hunters—of England. William Hunter, the older brother, left his family home in the Scotch back country to attend Glasgow University. He was a man of great wit and great charm; well groomed and well mannered, he had no difficulty in entering the circle of cultured society and he became a very successful practitioner among the élite. His scientific thirst, however, prevailed over his social ambitions. The test tube won over the teacup. He used his fortune and his influence to build a celebrated anatomical theater and museum where surgeons of his period gathered for discussion, dissertation and instruction. He underwent many denials in private life, denied himself the country estate, stables and kennels of his fashionable friends, never married, in order that he might give most of his attention to his work. His specific contributions to science were treatises on the

physiology of pregnancy. He made extensive studies upon aneurysms, fractures and dislocations and wrote a classical history of anatomy.

He had a younger brother, John, who had grown up on the family farm into a crude, loutish lad whose chief aim in life was to see how much energy and time he could spend in doing nothing. And he contrived to do nothing in a blunt, ill-mannered, almost uncouth way. Rough in appearance, brusque of speech, bullying in attitude, he was the complete antithesis of his brother. In despair, John was sent by his parents to William in the hope that William's influence would smooth and refine the knotty personality of his brother. In the environment of the older Hunter, John found himself the proverbial bull in the crockery shop as far as his social adjustment was concerned, and an unconvinced rebel in his reaction to William's explanation of natural phenomena, particularly in so far as they referred to health and disease. John Hunter's first job was assisting at post-mortems in his brother's theater of anatomy. But John was far more interested in the appeal of living surface anatomy than in the sermons of dead organs, and in this day would have thought that Ziegfeld gave a far better show than the Medical Center; so he frequented the pits of cheap theaters and courted the pitfalls of cheaper taverns to the despair of his gentleman brother.

Pan has ever been a diverting deity, but he has ever repaid the devotion of his followers with ennui. Science, however, not symbolized by any god, holds its devotees with a grasp as firm as pleasure, and renews their strength like Atlas's each time they touch its fascinating domain. So, tiring of the banalities that failed to stimulate his Celtic imagination, John Hunter permitted himself to be bitten by a scientific tarantula and was soon dancing in scientific company. He found the music, however, to be too stereotyped to satisfy his fantasy. Genius, like murder, will out; and having acquainted himself by assiduous study with the little concrete knowledge that his brother and his fellow surgeons imparted to him, he soon realized that all around was a living world which had scarcely been penetrated. Problem after problem rushed upon his awakened imagination. Like some cataclysm of Nature that rears a mountain where there had been none before, a great implacable unrest had sprung up in the mind of this young man and he was

soon asking questions that baffled his superiors, who blushed and left them unanswered. How did one form of life differ from another? Man in his arrogance considered himself made in the image of God. Did he really differ from an animal? What went on in the body of a man that did not go on in the body of a lion, or a bear, or a dog, or a cat, or an insect? He developed an avid curiosity about life, deleting all metaphysical phases that others resorted to when they approached problems they could not answer. He saw life, not only in the human body as a whole, but in every part of it. He felt that the lower forms of life were only variations of the higher. Their functions, he thought, were only simplified versions of the functions of the higher types. Once he had formulated his problems, he set to work with the intensity of genius to prove them. Fielding Garrison, the historian, compares him to a "restless high-spirited horse, pawing the air," impatient and resentful of the fact that even the longest life would be very short to satisfy his intellectual cravings.

Hunter determined to study life from its beginning, so he practically laid the foundation for comparative embryology and comparative physiology by studying embryonic life. He invaded every nook and corner of the animal kingdom, obtaining his material by hook or crook. He struck a bargain with the keeper at the Royal Menagerie for the bodies of all animals that died and bought or stole as many of them as he could alive. Within a few years, there appeared on the outskirts of the city as strange a laboratory as ever existed outside the pages of eerie fiction. Here, on a large estate, John had created a very weird experimental farm. He built a wall about it against prying eyes, and tunneled a secret passage below the ground where he constructed a cave-like work-room dimly lighted by candles and oil. To this secret retreat he took his specimens to be able to study them to his heart's content and gratify his passion for scientific investigation. In this scientific curiosity shop might have been seen everything from an itch-mite to a skeleton of an Irish giant.

The discoveries of John Hunter are too various and too numerous to be satisfactorily described. Briefly, he anticipated the evolutionary hypotheses of Darwin. He asserted the stability of germ plasm; he clarified the problem of hibernation in reptiles and ani-

mals; he described the influence of circulation upon growth by tying off the blood supply to the antlers of a deer and noting their disintegration. Forced feeding by means of a tube and artificial respiration were two of his contributions to the story of health. He described more than five hundred different animals and at his death left some thirteen thousand specimens to his brother's museum.

In Hunter's day, venereal diseases were not at all differentiated, but all were considered to be varying forms of the same cause. Purposefully, he inoculated himself with syphilis so that he might give, from personal observation, an accurate description of the disease. This, unfortunately, asserted its pathological ramifications by hardening his coronary arteries which supply blood to the heart and in his later years he was afflicted with angina pectoris, of which he left a classical description to posterity. In practical surgery, Hunter described shock, phlebitis, pyæmia and intestinal obstruction and made epoch-making studies of inflammation in general, gunshot wounds, and surgical diseases of the vascular system.

With indomitable spirit and with Scotch tenacity, he kept on working and teaching, though walking in the shadow of death. Quick tempered and irascible, he once remarked in his despair, "My life is in the hands of any rascal who chooses to annoy or tease me." In a sense, this was his epitaph, for it was during a stormy discussion with his fellow scientists that a fatal attack overcame him.

It was just about this period that surgery of the eye began to develop and modern treatment of cataract by extraction of the lens was originated. Jacques Daviel, a Norman, who had studied with an uncle, took up his surgical practice in Paris and won such acclaim through his skill that he attracted the attention of Louis XV, who made him his personal eye surgeon. The second eminent figure in the same field was Thomas Young, an English Quaker, who was noted as a scholar long before his reputation had spread as an optical surgeon. He had been referred to as "the father of physiologic optics." His particular interest centered on the mechanism of the eye and he was the first to give a description of that very popular eye difficulty—"astigmatism." Color vision next occupied his attention and during a study of retinal structure, he declared color-blindness to be due to deficient response of these structures to the

normal stimuli. He was the author of the theory that light waves are caused by vibrations in the ether and he introduced innumerable operations in eye surgery. He was without doubt one of the most versatile of surgeons. As a student of Egyptology, he was one of the earliest decipherers of the historic Rosetta Stone which supplied the clew to decoding the Egyptian hieroglyphics. He also went in variously for shipbuilding, lighting, standardizing the clock, measuring distances, and tidal phenomena. He is credited with being one of the first to consider life insurance.

Generally speaking, the eighteenth century saw a greater advance in internal medicine than in surgery. This was due largely to the fact that the printing of specialized textbooks made it possible for many students to acquaint themselves with medical subjects. Surgery could not be taught from the book.

The end of the eighteenth century saw a wide gap between the time-honored fraternity of physicians and the new cult of surgeons. It was something of the attitude that legitimate actors have for vaudevillians—a certain disdain and contempt for professions that were without tradition. And then a most significant event caused fortune to smile upon the surgeons. Glorious Louis XIV developed, among other infirmities, a fistula which made even as well-upholstered a throne as his, uncomfortable to the royal seat. All the salves and balms and unguents of the medical men brought no relief to his majesty's misfortune. A certain Dr. Felix, a surgeon, operated on him successfully and the licentious Louis was so grateful that he smiled upon the surgical profession in general and established Felix and his successor, Maréchal, as court surgeons. The influence of surgery grew. And soon after Louis XV succeeded, Maréchal wheedled him into establishing five chairs of surgical instruction at St. Come. The physicians of Paris went on strike. They resented the intrusion of the surgical mountebank. They paraded to the university on a bitter winter's day, their red robes gleaming in contrast to the whiteness of the snow, and jeered and cursed in anger. The appointment of Maréchal, however, remained, and it signalized a victory, both social and professional, of the surgeons over the practitioners of medicine. The doctors who had refused to grant the surgeons any position of importance were now compelled to eat humble-pie which, however, resulted in the establishment of

the inseparable relationship that exists between the two arts to-day.

Meanwhile, a new spirit was being born in this new land of ours, which, with the Revolutionary War, began to cut its scientific wisdom teeth. When the revolution opened, American authors had contributed but one medical book and a few pamphlets. Even as in Europe, it was war that taught this nation its early surgical lessons. A young, disorganized nation, unprepared for the emergency that threatened its existence, it found itself suddenly confronted with the necessity for building hospitals and securing instruments and drugs. George Washington did a great deal to spur the country to action and it was through his two personal army surgeons, John Morgan and William Shippen, that the organization of American medical education began.

Those good Americans who love to boast of achievements under the Star-Spangled Banner, have somehow overlooked the very notable contribution to surgery made in those struggling years of the nation's youth. Our boys are taught to salute the flag, they are taught to be proud of their national military heroes, their statesmen and inventors. But those illustrious pioneers who have contributed more to the health and strength of the nation than army or navy, court or school, who wielded their tiny swords in defiance of man's most pernicious enemies, the microbe and the cancer, have remained unsung. It was in our own United States that courageous and vigorous youth tore down the old fears surrounding intestinal surgery and proved to the world that it could be done. For years, the peritoneum had been a No Man's Land in which none dared to explore. Every effort that had been made had resulted fatally, so that the "Hands Off" sign had long since been posted, and all respected it. The same had been true of chest operations, where the pleura had proved the ally of death.

Then, near the eighteen hundreds, a scientific melodrama was staged in the American wilderness. Kentucky was just emerging from a wild land and the pioneers were just beginning to organize their communities. In the little city of Danville, on the border of unconquered wilderness, a young doctor by the name of Ephraim McDowell had hung up his shingle. He had settled with members of his family at an early period of the state's development. His practice was that of the typical pioneer doctor, necessitating long

horseback rides over virgin country and meeting every form of physical infirmity with the crude tools at his command. Thus, poorly equipped, he went one day to the bedside of an obscure settler, Mrs. Jane Crawford, whose heroism deserves a place beside that of every historic feminine figure. For Mrs. Crawford was the medium through whom Dr. McDowell was able to prove that abdominal surgery could be successfully performed. And the circumstances under which she faced her crisis required Spartan courage. There she lay, suffering from an ovarian cyst, a condition which had never before been successfully operated upon. These tumors of the ovary had always been permitted to grow until they exhausted their host. At times the tumor weighed more than the patient and a lingering and painful death was its inevitable accompaniment.

The operating room was the living room in a primitive cabin; the operating table was a crude thing hastily made from a few boards; there was no anæsthetic and there was no medium for preventing infection. Added to this was the storm of public indignation that had arisen among the rugged pioneer families when they learned that the operation was to be performed. Hours before, they had gathered angrily at the roadside and taken a vote to stop its accomplishment even if they had to hang the practitioner. In the best fashion of the movies the mob marched on the little cabin. Meanwhile, the young doctor had begun his operation. He could hear the wrathful rumble of their voices as they approached. They came to the very door of the house and threatened to break it down. Inside, the doctor worked on, quite unaffected, watched and guarded by a terrified negro mammy in a red bandana, and a worried husband. And because she realized the seriousness of the situation, Mrs. Crawford made no outcry, however excruciating the pain may have been. The operation had been completed before the mob could break in and the smiling doctor instead of walking into a noose, happily informed the group that a great surgical feat had been successfully achieved. Word of this miracle work flashed around the world, and almost overnight the obscure wilderness doctor became a historic figure. Realizing the difficulties he faced, it seems almost miraculous that his effort was successful. Many were later to try and fail; and many more, including Dr. McDowell

himself, were to repeat his success and prove that it had not been an accident. Effete and aristocratic Europe, where such operations had long since been abandoned, was particularly impressed. McDowell was inclined to give due credit to his teacher, John Bell, of Edinburgh, who had made him sympathetic with the almost hopeless fate of women suffering from ovarian diseases. The reputation he established caused him to be in great demand in future similar operative measures and within a few years he had repeated it thirteen times with eight recoveries to his credit. In Norwich, Vermont, another wilderness post at that time, Dr. Nathan Smith had successfully attempted the same operation, quite in ignorance of McDowell's previous work; and the Atlee brothers of Pennsylvania were the first to take it up in the major cities and specialize in the operation.

With the discovery of modern anæsthesia and the development of modern antisepsis and asepsis, the story of surgery is one mainly devoted to inventions, improvements and refinements of procedure. With the development of bacteriology, the nature of wound infections was definitely determined. The pernicious little germs, the Streptococcus and the Staphylococcus were traced to their sources. Instruments were boiled, hands diligently scrubbed and eventually rubber gloves were worn. Gradually the menace of infection disappeared. Surgeons became bolder. Their incisions became deeper, thus opening up greater territory for surgical procedure. Wounds were beginning to heal by so-called primary intention. Drainage was unnecessary where asepsis had been observed. The consequent scars were firm, and not thin and elastic, so that the frequent hernias, which followed operations, were avoided.

Medical men, who had been taught that the knife was to be the last resort and who usually submitted their human material to the surgeon when it was too late, were now beginning to realize that, when applied to hidden infection, or stone or strangulation or new growth, it was the knife that contributed the "kindest" and even the "shortest" cut toward saving human life.

It is impossible to catalogue the long list of names, and innumerable procedures and operations that have been devised, in the advance that surgery has made in the last fifty years. Not only the abdomen but the chest has been successfully exposed to the surgeon's

endeavor. The maimed and deformed have been restored to the ranks of the capable. Where disease has come in the form of abscess, or ulcer, tumor, or cancer, the surgeon's knife has frequently been the means of avoiding the inevitable sentence of death. Thanks to the daring genius of such men as Sir Victor Horsley and Harvey Cushing, the human brain has been exposed and successfully operated upon for conditions that betokened agonizing pain, blindness, imbecility and lingering death.

A busy morning in the operating room of an average modern hospital portrays more drama, more tragedy, more comedy and more adventure than would be seen in a whole season in the theater or found in a catalogue of novels.

A moribund woman is wheeled in, attended by physicians and nurses in spotless white. For a week the bowel has been paralyzed. An enormous tumor had been growing in the abdomen and the intestines had been matted down and strangulated. Clinging to an ancient fear, the patient had refused operation until a benign unconsciousness had destroyed the will that would have killed her. She is pulseless. She is breathing like an exhausted rabbit. Her lips are blue and her eyes are glassy. An anæsthetic is out of the question. In ten minutes the abdomen has been entered, the tumor removed, the intestines freed, stimulants applied; and then the abdomen quickly closed, the function of the bowel restored and recovery of the patient obtained, to the joy and gratitude of those who love her. To the surgeon, this is just another case.

A child is born, a boy—a son and heir—to the anxious and loving parents. Happiness thrills through the household, when the gloomy announcement is made that the child is bleeding slowly to death, afflicted with a congenital tendency to hemorrhage. No time is wasted. The blood of the father is transfused into the body of the child. The hemorrhage is arrested. The child survives.

Or perhaps, a young and beautiful woman has confided to her husband that he may be prepared sooner or later to be a father. All is blissful anticipation in the household. Suddenly she experiences a sharp pain, falls to the ground and is as white as alabaster. There has been a pregnancy in the tube and it is ruptured. Death is imminent. Then the surgeon. A hypodermic of morphine. Rapid anæsthesia. An arm prepared for transfusion

while the belly is opened and the bleeding tube removed. Better luck next time. But a mother has been saved. A father prays to the mercy of God and a surgeon calls for his next case.

A Sicilian laborer is brought in, his face pallid, but his eyes gleaming. "Vendetta" is all he can mutter. A small knife wound over the heart and the physical signs of hemorrhage in the chest, signify that he is about to pay the extreme penalty for some ancestor's crime. But surgeons are not the arbiters of our morals. The heart is exposed. A quarter of an inch more and the patient would have been taken to the morgue instead of to the hospital; and while the heart is beating with emotional rhythm, the deft fingers of the surgeon are plying with fine suture and delicately closing the wound that was the gateway to a certain death.

There are still many more cases to be operated upon. They run the whole gamut of pathology. Lunch is a cup of coffee and a cigarette; and the afternoon and the night continue with infinite variety the program of the morning.

CHAPTER XV

Regulators of Life

At the county fairs and street carnivals, the rain-streaked, gaudy banners of the side-shows contrive to shock or charm the eye with grotesque chromos of "the world's greatest collection of curiosities and wonders." From his ataxic platform a barker ballyhoos, "those unusual people"—"the bearded lady,"—"the human giant"—"the dwarf"—"the fat lady"—"the living skeleton!" The gawking crowd shuffles through the sawdust, stares, marvels and chatters, and walks away, remarking upon the strange ways of the Lord. Not one in a thousand has recognized that in this airless, aromatic tent, he has had the opportunity of looking upon a clinical display of some of the abnormalities that human glands can create. Little does the average man realize that there, but for the grace of glands, stands he.

Thanks to the Barnums of all time, man has swallowed unquestioningly the idea that the potter's hand slipped when it fashioned those queer creatures whose presence on earth seems to have so little rhyme or reason. For centuries they have been taken for inexplicable beings, suffering from creation's curse. Our present-day knowledge, however, tells us that Tom Thumb or Fatima or any other freakish variation from normal form and structure is nothing more or less than an individual whose so-called endocrine glands present anatomical and physiological pathology.

Not only physical appearance, but mental make-up, moral trend, and emotional tendency are to a large extent dominated by the chemical substances elaborated by these internal regulators. Their deficiency or excess of function determines to a great extent the genius and the idiot, the saint and the sinner. And furthermore, their function is so intimately connected with life itself, and with our conduct and dispositions, that they not only produce diseases peculiar to themselves, but influence the clinical picture of practically every known malady.

The unusual, the mysterious and the remote have ever been sources of wonder and amazement to credulous humanity. Three generations will simultaneously look upon Tom Thumb tickled with the vicarious pleasure that the quaint incites. But their reaction is no different than it was in the good old days of the Pharaohs. For the mightiest kings of ancient times held the Lilliputians in awe mingled with superstitious fear. If you were to visit to-day the Bulak Museum in Cairo, you would be confronted by the tiny stone likenesses of Khnoumhotpou, a dwarf of the third dynasty whose death was honored by a most magnificent and elaborate tomb and an immortal shrine. Scattered about the Egyptian ruins you would also find innumerable carvings of midgets, while dynastic history is replete with tales of kings who literally combed the earth that their court might boast of a midget minion. Very often the dwarfs were considered to have miraculous powers and their every movement was closely watched in the hope that they would utter some momentous prophecy.

When Paul du Chaillu came out of Africa, he brought with him some terrified black pigmies, members of a malformed and stunted tribe, whom he found pursuing a primitive existence in the African jungle. These pigmies made a great hit with the public. They chattered like monkeys in an incomprehensible gibberish and the superstitious soon believed that they were speaking a mystical tongue and were children of the devil. Inbreeding and unwholesome diet had produced glandular and trophic disturbances resulting in their constitutional deformities.

The metamorphosis of these misfits into the modern clown is a self-evident bit of evolution. The pigmy pets of the Pharaohs became the deformed jesters of the European courts, the Punchinellos, the wearers of the motley—in a word, the clowns of to-day, who substitute grease paint, stilts, rubber stomachs and huge hands and feet for the unfortunate deformities of glandular disease.

A study of the practices and beliefs of the ancients shows that a primitive phase, if not a developed comprehension of the gland theory, had been caught and emphasized. As early as 1800 B.C. principles of therapeutics were based on a vague concept of this idea. When the ancients of Egypt, Persia, Greece, Rome and other lands brewed their remedies from the extracts of the organs of ani-

mals, or ate them entire, they were hoping to obtain substances they felt were lacking in themselves. And when they went to the early apothecary and asked for a few ounces of fox lungs, or shedded snake skin, or dried wolf's heart, it was with a confidence that they could transfer the vital properties of a specific organ and thus revive the waning activities of a similar organ within their own bodies.

To-day we know that every organ that functions normally, and within its physiological capacity, gives no indication of its physical presence. We are not conscious of our circulation, or respiration, or assimilation, or digestion so long as the organs that carry on these duties are in a state of health and normalcy. When we become aware of these internal activities, either through discomfort or through pain, it betokens that the organ in question is either out of harmonious adjustment, or diseased.

We may say, for the sake of convenience, that there are two sets of organs in the human body,—one set that carries on the vital functions and another that presides over and regulates the manner in which these functions are performed. Among the former we have the brain, the heart, the lungs, the liver, the kidneys, stomach and intestines. Among the latter, we have the series of glands whose names are not so familiar. They supply chemical substances to the human economy and not only hold the baton over the orchestra of the aforementioned organs, but to a great degree determine the structure, form and nature of the individual who possesses them. The concord and discord between the vital organs and their glandular timekeepers is presided over by the great sympathetic nervous system, which is made up of those animate wires, the nerves, that carry millions of messages coördinating the demands and supplies of man's intricate structure.

Before the days of Hippocrates, it was known that the body secreted and excreted certain substances which were practically medical barometers indicating whether or not all was fair and warmer inside. What little animal experimentation was done, showed men that certain organs in the body had ducts and poured forth secretions.

It was Claude Bernard who first coined the term "internal secretion" and found the liver to be a very busy little manufacturing plant, as we have stated in another part of the story. Then Minkow-

ski and von Mehring picked up the trail and showed that the pancreas was an earnest competitor of the liver.

With the development of physiology and organic chemistry, the specific functions of these glands and the chemical structure of their secretions were established. Moreover, certain substances were discovered whose chemical nature remained obscure, but whose presence was essential to the normal processes of digestion. These were the so-called enzymes,—such as pepsin in the stomach, secretin in the pancreas, and enterokinase in the small intestine. Even as "one lamp lights another nor grows less," do these enzymes lend their offices to the process of digestion and assimilation, without altering their own chemical character.

These glands, then, whose secretions were readily attainable, such as the stomach, intestines, the liver, the pancreas and the kidney, were easily studied and their physiological functions more or less fully established. One of the best methods for ascertaining the influence of any particular organ upon the human economy was to cut it out and see what would happen.

In the year 1890, Naunyn, a Strassburg physician, chanced to be sitting in the hospital yard watching some dogs which had been used for laboratory experiments. It was a hot, sunny day and many bothersome flies were buzzing about. But for some strange reason they were not bothering him. Instead, they were gathered like a tiny black cloud just over the dogs. At short intervals they would swoop down attracted by the dogs' urine. Naunyn's curiosity was aroused. He called for a container to get a sample of the dogs' excretion. A few minutes later in the hospital laboratory he found the specimen to be full of sugar. He hurried to the professor who had been carrying on the experiments. He learned that all the dogs had had the pancreas removed. "Well, I can tell you what happens," Naunyn replied. "The dogs develop diabetes." And so it came about that the removal of the pancreas was established as a cause of the disease which had clinically been known since the days of Aretæus, long before Christ. Strangely enough this Greek physician described the disease as one in which "the flesh melted and flowed away in the urine."

Soon research was rife in the realm of pancreatic function with regard to the metabolism of sugars. About ten years before this

time, Paul Langerhans, sitting over his microscope and studying a section of the pancreas, noticed clusters of tiny cells that had an entirely different structure than the cells of the glandular portion. These clusters of cells have been given the name of "the Islands of Langerhans" in honor of their discoverer. Further research soon proved that if these cells functioned improperly, diabetes would result.

We have said that when starches or sugars are taken into the system, they are converted into a soluble grape sugar or glucose which is the fuel from which we derive our dynamic energy. This glucose is absorbed from the intestines and sent on to the liver where it is changed into a non-soluble product named "glycogen." This glycogen, or animal starch, is stored away largely in the muscles. When effort is required, there is a call sent out for glycogen. This is rushed back to the liver, reconverted to glucose and made ready to supply the body's activities. When the Islands of Langerhans are diseased, there is a perversion of this normal process. The sugar is not converted into glycogen but is directly absorbed into the blood and eliminated by the kidneys or only partially converted by the liver into glycogen so that there is an insufficient supply and the tissues themselves are deprived of their normal nutrition. The result is gradual starvation, and even death if proper treatment is not instituted.

Only very recently did Dr. Banting, of Montreal, discover "insulin," which is the active principle of the Islands of Langerhans and is secured from the pancreas of young animals. It has been a marvelous contribution to the treatment of the disease. Where the human pancreas, through disease or atrophy, has lost its capacity for function, insulin replaces the deficiency. Diabetes has lost its tragic aspect. Afflicted patients have been snatched from the very brink of death and restored to happy and useful lives.

Whether comedy or tragedy, man is the greatest drama. It should be apparent by this time that a simile can be drawn between the organs in the human body and the characters in a great play. The body is like Shakespeare's world stage with an all-star cast in the leading rôles. The minor parts are supported by players whose names may not appear in electric lights but who are just as essential as the stars in supporting the integrity of that vague yet vibrant

mystery, called life. There are many actors and understudies who, at a moment's notice, replace a faltering member of the cast. We, ourselves, and the loved ones about us are vitally interested in keeping the show going as long as possible—to postpone the inevitably tragic end until it shall practically make no difference. Occasionally one or more of the actors forget their lines, or skip entire scenes, or for a while give undue importance and overemphasis to their natural functions. The result is discord, disease—a pause in the play. Anxiety sits not only upon the aspect of the actor, but upon the faces of his sympathetic audience. Occasionally the curtain is dropped, at times to indicate merely a termination of an act and to permit a change and shifting of scenery—at times never to rise again.

The mystery element in the play has been supplied by the ductless glands. For centuries they were considered by the most observing critics to be playing merely minor parts. Their rôles appeared to be unimportant and their significance had not been understood.

Then, about the middle of the nineteenth century, there came to the notice of Thomas Addison, an English physician who was working with the eminent Dr. Bright—of Bright's disease fame—in Guy's Hospital, London, several patients who presented peculiar clinical pictures. Their most striking and characteristic symptom was a progressive, gradually deepening pigmentation of the skin. They became bronzed, and even black as the disease progressed. They showed an extreme degree of fatigue—the blood pressure dropped —digestive disturbances developed—severe secondary anæmia set in; the pulse became unusually soft and compressible. And they all died.

What, pondered Addison, was the cause of this mysterious and deadly malady, which so subtly and completely undermined an individual and which, like the sinister figures of a detective story, left no clinical clews?

He turned to the post-mortem for his solution. And now an astounding fact revealed itself to him. The patients had not been stricken by any of the usual organic disturbances—nor had they been attacked by some undiscovered microbe—but, in every instance, the adrenal glands of the individual had been destroyed.

"Strange," Addison may have said to himself. "Truly amazing!

Here is a gland we have taken little heed of, and yet without it a man blackens—even as a bit of charred wood—and dies."

And so, for the first time it became evident that a gland secreted a substance which, entering the blood stream, could influence the distribution of pigment, or the functional capacities of muscles, and was essential to life itself.

The entire world of research was stimulated into action when, in 1855, Dr. Addison's paper appeared with the statement of his findings in what has become known as Addison's disease. It was not, then, necessary for a gland to have a duct in order to produce a biological substance extremely necessary to human welfare. If such strange things could result from destruction of the adrenal gland, what might the others be doing?

Up to this time these glands had been considered enigmas of physiology, placed in the human body with no purpose other than to bewilder the investigator. Of all the glands, the most accessible for observation and study was the thyroid. It was situated in the front part of the neck, just above the breast bone. Innumerable amusing explanations for its presence had been made throughout the centuries. The early Romans had associated it with virginity. There was an old Roman law, under which the necks of girls were measured just above the thyroid to test their maidenly state. For generations it was dismissed as a kindly present from Nature to produce the graceful rounding of the throat. Some connected it with respiration, since it was located near the lungs—some thought it had something to do with dreams and still others with the functioning of the brain.

Its frequent enlargement had attracted their attention. Juvenal had mentioned this throat swelling in his writings. He said the malady was so prevalent in Alpine neighborhoods that it attracted only passing attention.

Pliny also wrote about it, and Paracelsus, spending many years in Alpine regions, had noticed that idiotic children often were born to women with goiterous swelling about the neck and had announced the conclusion that this was the explanation of all insanity and feeble-mindedness. This immature theory was, in a more recent day, to receive partial substantiation. And, then there was Roger, of Palermo, the great Italian surgeon, who found that a brew made

from seaweed was very effective in treatment. To-day, of course, we know that seaweed is heavy in iodine content. The reason why so many persons in the Alpine country—and in certain sections of the Great Lake belt in America—suffer from goiter is simply that the waters consumed have an insufficient iodine content, and this the thyroid needs, since it makes its own iodine product. If it cannot turn out the necessary supply, it has to expand its plant when extra work is demanded. Hence the neck swells and produces one form of goiter.

More light was thrown upon the subject when, in 1825, the posthumous writings of Caleb Parry revealed descriptions of eight cases of enlargement of the thyroid gland. These were associated with palpitation of the heart and with protruding eyes. The disease was more fully described by Dr. Graves and Dr. Basedow in 1835 and 1840, respectively. They stated that, in addition to the cardinal symptoms mentioned, there was a tremor and a generally increased excitability, associated with a speeding up of all the physiological processes. The patients lost weight, perspired profusely, were prone to diarrhea, were mentally alert, restless and apprehensive, quick of temper, easily agitated and easily fatigued.

In 1873, Sir William Gull, an English surgeon, was first to describe a disease he called myxedema. Here the thyroid gland was deficient. The patients presented an appearance which was the clinical antithesis of the so-called exophthalmic goiter previously described. The patients were dull, phlegmatic, obese, all physiological progresses were retarded and their mental activities limited to a very narrow scope. This condition of myxedema was observed to occur whenever the thyroid gland was completely removed by surgery. Theodor Kocher, a Swiss surgeon who had performed thousands of operations upon goiterous persons, noticed the changes in physique, temperament and mentality that Sir William Gull had described.

Then there was another condition that engaged clinical interest. Children were born, apparently normal, but soon after birth their faces became large, their features bloated, eyelids puffy and swollen, the abdomen was prominent, the legs thick and short and the hands fat and pudgy. These children had a waxy, sallow tint. Their physical development was very slow, and mental progress even slower. Their skins were very dry. They were very constipated.

In spite of the fact that their appetites were poor, they gained in weight. But they did not grow. Many of them remained dwarfs. This condition—Cretinism—had been known since ancient days, but its association with the congenital absence of the thyroid gland was just beginning to be established.

The anatomical position of the other glands of internal secretion had been established. Their physiology, however, was unknown. There were three avenues of inquiry open to the investigating scientist. The first was to observe a disease, note its clinical picture, its symptoms and its occurrence, and then from post-mortem findings establish the pathological relationship to the clinical entity. The second was to remove the gland from an animal and note the effects. The third was to feed an animal with extracts of a specific gland and note those effects. For the sake of clarity and convenience, we believe it expedient at this time to enumerate the various glands, to state their functions, note their interrelations, and to show how underdevelopment, disease and atrophy influence the health, the structure, the disposition and even the intellect of the human being.

One may well question at this point why it is that these very important glandular organs have kept the secret of their functional activity through the centuries. To-day there are doctors who specialize in diseases of these glands. Competent medical observers have lived since the days of Hippocrates. Why did they not at least empirically describe the conditions which fill our modern medical journals? The answer is not difficult. Man achieved comfort and stability by a slow process of adaptation to an environment that changed progressively but slowly. No organ normally formed will function abnormally unless it is put to unusual stress and strain. The dictates of habit are as old as time. We follow in the footsteps of our fathers. Our physiological adjustments are timed to the beat established by our forefathers. In the past generation man has been compelled to keep pace with machinery. Life has been speeded up to an unusual degree. Our senses, accustomed to a certain number of impressions, have had these impressions multiplied by an incalculable factor through modern invention and the modern economic struggle for existence. The glands, the regulators of life, have been whipped to action beyond their accustomed capacity. The result has been, first, disfunction; second, disease. The knowledge

that we have obtained of the action of these glands in disease has enabled us, to a certain degree, to understand their relationship to normal metabolism. It has also taught us to recognize slight variations from normal regulations and we have learned to note aberrations of their functions and disturbances in their activity which have escaped the eyes of the fathers of medicine.

There are seven such glands:

The pineal, located in the posterior part of the brain.

The pituitary, which hangs from the base of the brain.

The thyroid, erratic neighbor of the Adam's apple.

The parathyroids, which are from two to four or more bodies attached to the thyroids proper, but differing in structure.

The thymus, located in the chest.

The adrenals, perched at the tips of the kidneys.

Gonads, or interstitials (ovaries or testes)—according to the sex of the individual—commonly known as the sex glands.

Concerning most of them not a great deal is actually known. Human society has become neither so enlightened nor so depraved as to sanction human vivisection. The animal has taught us a great deal. The transplantation of glands to human beings is furnishing some bizarre information. At best, we can only assert hypotheses and continue with experiment, learning from error as well as from success. We believe that their secretions are transported through the blood stream by means of hormones. "Hormone," a word derived from the Greek, means "a messenger." Hormones, then, are the messengers of the glands. Each gland creates its particular hormone, and sends it upon its particular errand. If, like the messenger boys of the Western Union, something happens to detain them, or hold them up altogether or send them to the wrong place —confusion results.

Many surmises, some wild, some conservative, have been made concerning the part the glands may have played in the general evolutionary processes. Quite recently, Sir Arthur Keith, before the British Association for the Advancement of Science, suggested that the leap from the anthropoid ape to man was occasioned by changes in hormonic action.

In connection with these evolutionary guesses, the pineal gland plays an interesting part. Located, as it is, in the back of the head,

it was looked upon for many centuries as "a third eye" which, somehow, had lost its capacity for all but "second sight." In fact some hold that the term "second sight" may have thus originated. This gland was, doubtless, first uncovered by some primitive surgeon, for many references to the "third eye" are made at an early period in time. Unable to explain its presence, the usual mystical mantle was cast over the clay of man and the gland became dignified with the title, "the seat of the soul."

What a blow, then, it must have been to discover that this same gland can be found in all forms of life! In fact, certain modern scientists have been inclined to consider it a probable solution to the mystery of evolution. They have pointed out that in tracing this gland through reptilian and amphibian life, they have found its location to be the same in every instance. Putting the pineal of a snake, a fish or a man under the same microscope, they have found the cell arrangement to be practically identical. So, they have inquired, if all life came out of the sea, why is it not possible that disturbances of the pineal brought changes in form and type? Whatever their improbability, such questions are always fascinating to ponder over.

At any rate, when the "third eye" and the "seat of the soul" ideas were first projected, the transcendentalists leaped upon them, and for many a century the occult-minded spoke of this mysterious gland as a source of wisdom, a seat of intelligence and a force that animated the super-mental telepathic feats of the seers. Descartes took the "seat of the soul" idea from the ancients and reintroduced it to Europe. Man's egoism, however, made it impossible for him to endow this gland with any such liminal attributes, when he found that he had to share his "soul seat" with the dumb animals. With the same capacity for nimble side-stepping so often displayed when his pride has ridden to a fall, he quickly changed his opinions concerning the pineal.

As a matter of fact, the part played, concerning which we have the most information, relates to adolescent growth,—both physical and mental. Its greatest influence is believed to end about the time of puberty, for, so it appears, its functional decline dates from that period. Atttention to this particular activity, especially its kinship to the sex glands, was noted by surgeons operating on tumors that

affected it. Where these appeared in childhood, the stimulation which followed resulted in a precocity of growth, especially emphasized in the sex organs. Children showing abnormal development of talent in any particular direction, such as infantile mathematicians, chess-players, and classicists, have been known to develop or to have had tumors of the gland, thus producing hypersecretion. An extract of pineal is commonly used in treating defectives.

The pituitary, because of its isolated residence, has been a particular stumbling block to the efforts of the student. The most important contribution to pituitary knowledge was made by Pierre Marie, a French surgeon, in 1886. While treating a tumorous condition, Marie noticed that stimulation of the glandular action, due to inroads of the disease, brought about a strange and startling overgrowth of certain bones. Somehow, his conclusions told him, this gland controlled the architecture of the skeletal structure.

Two of our favorite heroes, Jack of Beanstalk fame, and David, with his Biblical slingshot, had encountered enemies who were victims of what we now call "acromegaly," or a state of giantism. Giantism does not necessarily mean that the individual grows to the ogre-proportions of the folk tales, or that he reaches the size required of a side-show freak. It can appear in many forms. Most of us have seen people whose physical peculiarities are due to acromegaly. There are, for instance, individuals with huge hands, large jaws or noses, heads out of proportion to bodies, huge feet, wrists or arms—or with other members greatly exaggerated. They are inclined to be hairy with thick lips and thickened noses. Their frames are large and their mental processes slow. They undergo changes in voice and the tone often attains that sepulchral depth of the vaudeville basso.

Where the pituitary oversupply is only slightly in excess we see simply the large raw-boned type of man. And, where the disease occurs in woman, we have those masculine types, with deep voices, and dominant, atavistic natures. They become the "hairy women," with bushy eyebrows, mustaches and even beards.

In cases of pituitary deficiency, the reverse of this picture may be found. Babies thus afflicted are overfat, and unless given treatment in the first ten years of life are likely to face a somewhat unhappy

adolescence. The boys become exceedingly plump and show signs of effeminacy. They possess those piping "boy soprano voices" that crack with late adolescence and make them the butts of their playmates' gibes. The girls also are overplump little children, with overdeveloped fat breasts, and rotund, prominent bellies. Their hands are dimpled and tapering. They are usually bright and active until puberty, when a delayed, irregular, painful menstruation is apt to assert itself, making them fretful and inattentive. In marked types, mental and dispositional quirks are often noticed, and the "captive" type is frequently recruited from their ranks.

The posterior portion of this gland contributes a secretion which is somewhat similar in its action to the secretion derived from the adrenals but it has, in addition, a pronounced effect in stimulating involuntary muscles almost instantaneously. The property of the gland has been utilized to marvelous therapeutic effect in childbirth, and following major operations. Where a mother has become exhausted in the process of labor or where the womb is unable to expel its inhabitant, an injection of "pituitrin" immediately activates the exhausted muscle, and the stork is speeded in its flight. When, following the shock of surgical procedure, the intestines yawn with distention, the same preparation stimulates them to evacuate their paralyzing contents, and one of the most dangerous complications of the "kindest cut of all" is overcome.

That gland which particularly rules over youth is the thymus, which inhabits the chest and concerning which very little is known. We do know that its functions appear to end as soon as the child has reached its destined growth, and then it dwindles into insignificance. One of its chief responsibilities is to assist in the production and distribution of lime salts in the growing body. Where, for some reason, the thymus gland persists tragedy inevitably follows: such children die suddenly from trivial shock or from a minor operation, or even from the administration of an anæsthetic. They are delicate mollycoddle types, if they survive.

When your hair stands on end, when gooseflesh appears on your body, when nervous chills creep down your spine or your courage rises to the point where you would dare to correct Gene Tunney's English—the very liberal gland-man will tell you that your suprarenal, or adrenal, gland has opened its flood gates. It is a most

sensitive and easily disturbed gland. The emotions are the triggers which set it to firing. Moments of peril, anxiety or terror fan its flames. Fear—rage—passion—hunger—and all the other emotional states prompt its maneuvers. The mechanism of aggressiveness, impulsiveness and even courage—all contribute to its excitability.

To visualize this gland, one should comprehend that the adrenals are divided into two parts, each quite different in origin and structure. There is an outside covering called the cortex, which is composed of the same kind of tissues to be found in the genital organs, and it has a direct relationship to the reproductive system. It is the removal of this portion of the gland that brings death. In the center, or medulla, there is a cellular tissue, which appears under the microscope to be exactly like other little tissue-groups of the body, but which produces the secretory substance we know as "adrenalin." Most readers will have heard of the administration of "adrenalin" in cases where heart action and circulation were failing.

When the adrenal glands are overactive, the tendency to emotional instability is greatly enhanced. Almost every one has undergone the natural consequences of sudden fright, or has experienced some severe emotional attack. We have all witnessed people with "hysterics" or have had them ourselves. We have seen the blood flow from the face, leaving it blanched and ghastly; the eyes fixed and staring; the hair standing on end; the excited action of the heart, the labored breath and the upsetting of the digestive processes. These, and a score of other reactions—from cold sweats of terror to the "chip on the shoulder"—can be traced to adrenal hyperactivity.

On the other hand, we speak of people "losing their nerve," or being uncertain, indecisive, vacillating and timid, or easily fatigued and exhausted. Here we have the reverse situation. The gland is not contributing a sufficient adrenal supply.

All those conditions which doctors call "spasmophilic," where the involuntary muscles have a tendency to contract in a cramp-like spasm—such as occur in the larynx, intestines and ducts of glands—are due to irregularities of adrenal action. Urticaria, or the breaking out of the skin with large, itching hives, is due to the same cause in many instances. Hypersusceptibility to toxins, irritants and poisons, from pollens to drugs, is also associated with an adrenal insufficiency. Strange it is, that these little night-caps of the kid-

neys should have so many varied functions—but, then, strange indeed are the ways of the Creator.

The thyroid, like Hamlet, has opened libraries of discussion. Like Hamlet, too, it frequently masquerades in madness. It has as its most vital objectives the stimulation of human growth and the regulation of metabolism. Metabolism can be generally defined as the process of tissue building—the complete reaction of the body to its nutriment. The basal metabolic rate of the body can be learned by checking the amount of oxygen demanded in a given period of time. Whether the metabolic rate is high or low can be charted by means of a little machine utilized by the modern physician. This device tests the rate of consumption and the amount of fuel required by the energy processes in the human system.

The clinical picture of the hyperthyroid type includes a soft, moist, velvety skin; luxuriant hair, fine of texture; thin fingers; irritability of nature, nervousness, restlessness, tremors, a tendency to worry and anxiety; irregular, accelerated heart action, rapid breathing, insomnia—in general—increased metabolism.

The hypofunction of this gland produces pictures previously described, resulting from a greatly decreased metabolism. Like the adrenal, but in more constant fashion, the thyroid supplies the chemical whips and spurs to action. Without it, the human body is literally "left at the post." It is closely related to all the other glands through its innervation, and is so capricious that its delicate indications are apparent in every variation of life—both in health and in disease.

When in the pioneer days of thyroid surgery, removal of the gland was followed in certain circumstances by death in tetanic convulsions, there was pause for consideration and cause for research. Neighboring the thyroid, on either side, were found little groups of glands, which since then have been called the "parathyroids." Their function is not fully understood, except in so far as they preside over the stabilization of the calcium balance in the animal body. Removal of the gland is followed by an almost complete disappearance of calcium from the blood stream, and by the aforementioned tetanic spasms. These can be relieved by the administration of calcium salts. Apparently purposeless pensioners

of the treasury of life, they are essential to life itself in its regulating mechanisms.

Finally we come to the sex glands, of which so much has been heard by the present generation. It is amusing to contemplate how "modern" and "new" the whole subject has seemed to the parlor physiologists. Actually, here is one of the oldest subjects of consideration under the sun. It's a theme that runs in and out of mythology, folk-lore, fancy and fiction; it hurdles the chronicles of the human race and finds a place in the lore of the dumb animal kingdom.

The presence of sex deficiency is apparent to most of the lower animals. For the instinct of self-propagation must run through the entire living world, or else there would be no living world. An interesting and valid instance of the contribution of sex glands to animal personality is illustrated by an experiment conducted by a group of scientists, a few years ago. They emasculated a handsome, beautifully antlered elk in the Yellowstone Park Reservation. Within a season this magnificent animal became an outcast. He was disowned and shunned by his herd. Soon his antlers began to crumble, like the branches of a tree in which the sap no longer flows.

Again, the hyena is shown to be well aware of the part played by virility in the predatory competition of the forest. Thus the male of a hyena pack has been known to emasculate his own male offspring with his teeth when the younger member showed evidences of being a worthy competitor.

Virility in the male and femininity in the female—as such are commonly understood—are directly and specifically dependent, to a great degree, upon the integrity of the gonads. Animation and zeal, ambition and hope have ever possessed the soul of man to win the favor and affection of the female. Deprived of his masculinity, he sinks into desuetude and watches life go by with disinterest and listlessness. For him feminine beauty and charm have lost their allure, and since most of the works of man have been inspired by some woman, the eunuch, completely deprived of his sex glands, is no more than a bisected worm that drags itself along waiting for its end at sundown.

Knowledge of the effects of castration is as old as history.

Through the entire Orient, the eunuch was as casual a member of the average household as the butler is to-day. The chastity of women was valued much more highly than their lives. And until recent years, the Bosphorus was the frequent recipient of a sack containing the struggling body of an unfaithful houri. Moreover, the eunuch retained a beautiful soprano voice, and especially in Italy, fathers often castrated their sons shortly after their birth so that they might, in later years, take their places in the church choirs.

The operation of emasculation is as old as legend. One of the earliest seems to have been performed as the result of a family quarrel. Greek mythology relates that Uranus was the progenitor of all the gods. His first children were the Centimanes. His next progeny were the Cyclops, who were imprisoned in Tartarus, because of their great strength. This so angered their mother, Gæa, that she incited her next-born children, the Titians, into a rebellion against their father. Uranus was deposed. And in order to halt any further offspring, Saturnus, the youngest of his sons, successfully emasculated him with a sickle. The details of the operation were not recorded.

However, the operation was probably complete, for—as the procreative member and the gonads of the old god fell into the sea—their contact with the water resulted in the birth of Venus. Meanwhile, the blood that dripped from his wound fell upon the ground, and caused the giants, the Furies and the Melian nymphs to spring into life.

The entire story is merely symbolic of the primitive obeisance to fertility, but in this instance also illustrates the antiquity of the "birth control" idea.

The physical characteristics of the eunuch, his great size and the abundant accumulation of fatty tissue, the softness of his muscles and his delicate skin, inspired the breeders of livestock to attempt similar measures in preparing their cattle and fowl for the market. By removing the sex glands of the young rooster, they produced the flavorsome capon. The hog became fatter than ever and produced a far more palatable bacon. We do not eat the cow or the bull; our beef comes from the steer.

It was in 1887 that the famous Brown-Séquard decided to ascertain the effects of the injection of a sex gland secretion upon him-

self. He was then over seventy years old. He made repeated injections of an extract of the gland and reported that he felt much younger and much more alert, both mentally and physically.

From the time of Bernard to the present-day "monkey shines" of Voronoff, man once again persuaded himself that the fountain of youth was within his grasp, and in the light of our present knowledge the glands have given him the first glint of hope.

The sex gland contains two kinds of cells: those which form the germ-plasm, and the interstitial cells which contribute the internal secretion. The influence that these interstitial cells have on the dispositions and characters of animals is, perhaps, best illustrated by a series of experiments carried on by Dr. Steinach in Vienna.

Steinach found that the average life span of the female rat was four years. During the first three, she procreated. When she became senile, she was much less active and refused the attentions of the male. He transplanted the ovary of a young rat into her, when she again became active, reindulged her sex life and bore a litter of young. He then castrated young male rats and they grew up to be fat, docile, tamable creatures. When he re-implanted the gland, they developed their native, ferocious and predatory habits. He then transplanted the male gland into the female and the female rat developed a perverse tendency in her natural sex relations, acting more like a male than a female. From a biological standpoint, these experiments are extremely interesting. Steinach then originated his well-known operation in which he attempted to improve the waning functions of the interstitial cells of the testicle by deviating the entire blood supply of the gland to them. He did this by tying the duct, through which the sperm is emitted, so that the cells that produced the sperm eventually died through atrophy, and the interstitial cells were enlarged and revivified by their excessive nutriment. In certain instances, he achieved remarkable results in which old men attested to the fact that their general health and capacity for effort in every direction was considerably ameliorated. A similar result was produced in women by gland feeding and by treating the ovary with stimulating doses of the X-ray.

The general characteristics which mark the hyperfunction of the

male gland are: early development of the hair, especially under the arm and over the pubic region; a rapidly developing skeleton; a tendency to mental precocity and precocious sex activity and a greater capacity for muscular effort. Hypofunction of the gland produces an individual of the feminine type with scant, thin hair; white transparent skin; a tall, thin stature, with irregularly distributed pads of fat over the breasts and hips; or else a fat, sluggish type with underdeveloped genitals, mental dullness and lack of initiative.

Hyperfunction of the ovary similarly produces early development of hair and rapid development of the skeleton, premature menstruation and precocious sexuality. Hypofunction produces varying types. The predominant one is of infantile appearance with delayed menstruation, obesity and a general covering of the body with hair, very much in masculine distribution.

Autopsies on patients who have died from diseases of the glands, or in whom the glands have never functioned normally from birth, have shown that whenever one gland is seriously affected, practically all of the other glands are more or less involved. This interrelationship of the glands is easily understood when we realize that they are all joined by the great nervous system which presides over their activities. It directs their call to function, apprises them of their needs or warns them of their excesses. It is the kind pilot who steers these frail and sensitive craft, the Regulators of Life, in the hope of prolonging in happiness and health our strange interlude between birth and death.

CHAPTER XVI

The Body Becomes Transparent

THE room was dark except for a single tiny candle. It was in the year 1879, in London, and a group of scientists sat intently watching the shadowy movements of one of their fellows as he connected some wires to the ends of a slim glass tube. The ends of this tube were sealed with metal electrodes, and its air content had been exhausted as completely as possible. In other words, it was a so-called vacuum tube.

"I am going to show you the effect of electric current through this vacuum tube," said the demonstrator. He switched on his connections and snuffed the candle. Every one anticipated velvety blackness, but instead, as though in response to a divine word, there began to radiate from one end of the glass tube to the other a stream of gorgeous luminosity, interrupted by sparks of most brilliant light. Spellbound, the scientists realized that this was a moment marked by something more than a mere display of flaming color—it was a momentous incident in the history of invention. Before them stood a modern Prometheus who had snatched fire from some new element in this vast world of matter. They were not certain what this new element might be. They knew only that a new problem in the physics of light was confronting them. No one realized that this pyrotechnic display would eventually play a most vital rôle in the struggle of mankind against disease.

The inventor, William Crookes, who had fashioned this interesting tube, had no notion he was playing the rôle of progenitor to the X-ray and was opening a new chapter in science. He did not know he was crashing the gate of the atomic theory. To him, his experiment was a beautiful and fascinating discovery that he stumbled upon while exploring the unpenetrated continent of physics.

Genius lies in the man, not in his alma mater. William Crookes

was a man who could boast of being self-educated—self-made. He had been given only the most ordinary secondary schooling and had never seen the inside of a university. Yet here he was being hailed as one of England's foremost scientists, a future beckoning with a knighthood and the Presidency of the Royal Society. Dedicated to science, he had worked diligently in the realm of physics and had a number of ingenious and highly imaginative discoveries to his credit. There was, for instance, the "radiometer." To-day, you can see many of these instruments in the display windows of optical stores. It is a contrivance of four little platinum wings, or vanes, inserted in a semi-vacuum glass container. These wings are attached to a wheel, like the blades of a windmill. One side is painted black; the other shows the highly polished metal surface. They are in almost continuous revolution, as though they hinted at the answer to perpetual motion. Crookes had discovered a very simple principle of light and heat. When the sunlight falls upon the paddles, or wings, those sections which are black heat more quickly than those which reveal the polished metal. As Crookes explained, rays of light which fall on white surfaces are reflected again; rays which fall upon black surfaces are absorbed, the temperature is thus raised and molecular motion created. Thus the little fanlike plaything goes whirling about when the light waves fall upon it.

Our electric light of Mr. Edison's invention is due to wire glowing in a vacuum. Crookes was the first to throw a high voltage current through a tube sealed, as before stated, with metallic electrodes.

"The phenomena in these exhausted tubes," Crookes later wrote to the Royal British Society, "reveal to science a new world—a world where matter exists in the fourth state. In studying this fourth state of matter, we seem at length to have within our grasp the little indivisible particles which, with good warrant, are supposed to constitute the physical basis of the universe. We have actually touched the borderland where matter and force seem to merge into one another, the shadowy realm between the known and unknown, which for me has always had peculiar temptations. I venture to think that the greatest scientific problems will find their solution in this borderland."

As a matter of fact, he had actually crossed the borderline of which he wrote and didn't know it. He was smashing atoms, approaching Aristotle's dream of a primordial substance, demonstrating the first X-ray—and so completely unaware was he of what he had at hand, that when some photographic plates in the room were fogged, he marched angrily upon the tradesman who had sold them to him and berated him for dealing in such faulty wares. Crookes did not so much as suspect that his light might have had something to do with the condition of the plates.

But he did try to find out what sort of matter he was dealing with. And so did his scientific fellows. A veritable Klondike rush of experimentation was begun. His tube had been a simple affair: merely a bulb from which most of the air had been extracted. The positive terminal of the tube was an electrode (the anode) and at the negative terminal was the cathode. His tests with a magnet and a tiny rail-like contrivance proved to him that his sparks were negatively charged. And so they became known at the time as cathode rays.

It was also discovered that these rays revealed themselves in three ways: a lovely glow appeared in the tube; they gave off heat, since a metal object placed in their path grew hot; a dark shadow was cast on the tube opposite the cathode. And there it ended. There seemed to be no practical use for the toy. It was a vastly interesting physical phenomenon—and that was that!

A decade passed. Many men studied this fascinating subject. And then, one day, Fate again took a hand in the stage management of scientific drama. In his laboratory in Bavaria, in the year 1895, Wilhelm Roentgen was puzzling over the electric stream in a Crookes tube. It so happened that he had been giving a great deal of study to problems in phosphorescence. On a table, a number of feet from where he was working, had been placed some experimental accessories. One of these was a large card, chemically prepared with barium-platinocyanide, a salt with markedly phosphorescent properties. The light in the Crookes tube caused the card to glow. He held first paper, and then thin cloth, in front of the light and still the card glowed. Finally, he covered the light with a thick, black cloth. The barium card, across the room, looked as though it were covered with millions of golden crystals. Roent-

gen had good reason to be amazed. He repeated his experiment, using solid materials. The impossible was happening. These rays, in contradiction to everything that had been taught or known, were actually passing through solid matter. Only where matter was very dense did the rays fail to penetrate.

And so the significance of Crookes' scientific toy dawned upon the world. Roentgen refused to give his own name to his discovery and called the rays the "X-rays," using the well-known algebraic symbol of uncertainty. The excitement created by the announcement of the discovery still lives within our memories. It was almost as though a new world had been found and the inhabitants of Mars had been gazed upon. Overnight the possibilities of the new ray became a subject for international scientific speculation. The exposure of the photographic plates of Crookes had now been explained. With the discovery and the development of the X-ray, the human body has truly become transparent.

We shall not entertain the reader with the cold scientific relations of the X-ray to the advancement of our knowledge of the physics of life and their influence upon chemical theories whose dogma had now been relentlessly challenged.

The earliest X-ray machines were used largely in the diagnosis and treatment of fractures and dislocations. The result of a broken arm or a broken leg was taken out of the domain of uncertainty, perfect setting was possible and the progress of the process of repair could be visualized. Tumors of bone were diagnosed long before they became apparent to the ordinary methods of diagnosis. Gradually the rays were modified. Their clinical application was advanced until to-day practically no physical examination is complete without its X-ray information. By feeding salts of bismuth and barium, which are impenetrable to the ray, the functional activity of the stomach and intestines is easily established, variations in form and structure are brought to light, ulcers and tumors are diagnosed. Changes in practically every organ of the body are discernible through X-ray investigation. Accumulation of concretions resulting in stone formation so frequently present in the gall-bladder and the kidney and in the bladder are seen with the aid of the X-ray, making the differential diagnosis of these conditions practically certain. Early tuberculosis, so frequently missed even

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by our most astute clinical observers, is revealed by means of this same miracle of modern science. Pathological collections of fluid, serum or pus are similarly detected. Our modern conceptions of the production of disease as the result of absorption from some focus of infection so frequently found in human teeth owe their existence to this light that rarely fails. Within recent years, not only have fractures of the skull been revealed, which otherwise would have escaped all known clinical methods, but tumors of the brain have been localized while the groping neurologist was endeavoring to find some coherence in the varied and bizarre symptoms that the condition produced. In fact, from the standpoint of diagnosis, the X-ray has made the medical student of to-day a peer of his floundering father who had spent a life-time in the pursuit of the elusive art of medicine.

Life is a series of blessings and woes. Every cloud has its silver lining, and frequently the reverse is true. No pæan has been sung for those pioneers who first worked with X-ray, seeking only the welfare of humanity and learning only too late that the exposure to the ray that they unwittingly accepted inflicted grewsome burns which refused to heal. The ray, absorbed by the workers, ate into their hands like leprosy and the pain was so excruciating that death was welcomed to end the lingering suffering. Furthermore, it was discovered that they had lost their virility and that they had sacrificed on the altar of science the blessings of paternity. Like a two-faced Janus, here was a ray that could smile with diagnostic aid on one hand, and could maim and destroy with fiendish malice on the other. Man has ever met life's adversities with intelligent protest. It was found that the ray did not penetrate lead, so leaded glass and lead-containing apparel protects the modern worker.

The next problem that confronted the scientist was how to apply the destructive elements of the ray to some useful purpose. A long series of experiments was conducted in which it was found that the emanations of the X-ray could be either stimulating or destructive, depending upon the way in which they were used. One could, for instance, destroy all the hair follicles and the ray became a cosmetic boon to disfigured ladies. Then it was applied to cancerous growths. If the ray could destroy the tissue of a cancer without harming the healthy tissue surrounding it, it would indeed be a

blessing to humanity. At the present time, all over the world, the X-ray is being used in the treatment of cancer, sometimes with marvelous results, particularly where the growth is superficial, and at other times spelling failure that has ever been in the path of research. At this point, it may be pertinent to say a word about cancer. Eventually we all die, if not through accident or infection then through the surrender of some vital organ to the tide of time. Or else, we attain the last stage of life, "sans everything," and crumble like the one-hoss shay. But it is the rule of Nature to replenish the earth with her children, and those who are must make way for those who are to come. And so she has contrived cancer—an autonomous growth of tissue, emerging from some group of cells eccentrically placed or irritated into abnormal development, and sprouting without law or order, to erode anything and everything in its way—eventually killing its host. This it does either mechanically or by secreting poisonous saps that course through its victim and make life untenable. Modern research has concerned itself ardently with the cancer problem. Some think that germs are responsible. Others consider ferments the cause. To date there has been no satisfactory explanation of this killer of man. Millions of animals have been sacrificed in order to throw some light upon its mystery, but the only armament we have against it is early diagnosis, surgical removal before it has spread its hideous metastases throughout the body, and the application of the inhibiting and at times destroying influence of the X-ray and radium.

In the University of Paris, a scientist by the name of Henry Becquerel, enthralled by the revelations in the field of radiation, was devoting himself to a searching study of all phosphorescent substances. He was particularly interested in the fluorescent properties of such ores as uranium. One year after Roentgen had made his spectacular discovery, Becquerel made a test inspired by what he had learned regarding the X-ray. He took some photographic plates and placed them on top of a large block of uranium. He found that the plates became fogged. There was, then, something in this ore which emitted penetrating rays, even as did the Crookes tube.

Meanwhile, the most extraordinary woman science has ever produced, one of the most important women in the world's history, was

coming upon the scene—Madame Marie Sklodowska Curie. Hers is an epic story of struggle against every conceivable odds to the heights of achievement. She did not, in any sense, fit the popular conception of the woman trespassing upon fields long dominated by man. She combined a basic maternalism with every charm and virtue known to femininity. Her most absorbing scientific undertakings were interrupted by periods of darning the children's hose and doing the week's washing.

Marie Curie was on friendly terms with poverty. Left motherless when only a child, she was raised by her father, who was a professor in the so-called gymnasium, or college preparatory school, of Warsaw, Poland. Her father's income was very meager, he could afford no servants, and his duties at the school were so pressing that he had little time to devote to his family. Marie, however, seeking companionship, would follow her father about in his laboratory, held spellbound by the wonders of scientific experiment. Her father, to keep her interested, gave her little chores to do, such as bringing him material necessary for his work, cleaning tubes and beakers, and as she grew older, taking notes for him. These little errands of love made her idolize her father, and in her hero-worship she decided to emulate his life and dedicate hers to scientific pursuits.

But Poland was a Russian Province. The merciless hand of the Czar had fallen upon her people—Poles and Jews were often persecuted and faced with destitution. Quietly the hounded people organized for revolt. They bided their time. Marie was an active figure, as were all those of the intellectual classes. They held secret meetings and prepared for a day when they could strike against their tyrant. The Czar's spies discovered the plot and the police broke up their meetings. There was nothing to do but flee the country. Marie Curie hesitated. Which way would she turn? She decided on Paris where the universities were open to all and where they spoke a familiar language.

She was then confronted by the problems of existence. She had arrived with an empty purse, and no prospect of employment. She had taken a dingy room in the slums. It was winter. She could buy no coal or wood. She allowed herself a few sous a day on which to survive. She was determined to work in or around the

university. At the Sorbonne she got small jobs, such as washing bottles or sweeping. Then she arranged to coach a few pupils, tutoring them in physics and mathematics.

Finally she obtained a position, helping a professor in his laboratory work. Her ability at once aroused his interest. He wanted to know more about her, found that she was the daughter of a professor and insisted that she get a chance to advance her education. A number of people befriended her—among them, Henri Poincaré, brother of the later French premier. It was arranged that she should be given special instruction by Pierre Curie, a struggling young professor of physics, metallurgy and electricity. She was now twenty-nine. Here were two earnest young students with kindred hopes, similar ambitions and dedicated to the same pursuits. Naturally they were sympathetic with each other's struggles and efforts, and since they had been thrown into the companionship of a common task, it was inevitable that romance would seep into their lives.

Mme. Curie—for she had now linked her fate with her tutor—had been intensely interested in the Becquerel discovery that uranium was a radio-active substance. Her zest for research prompted her to inquire what other elements in matter had similar properties. There must be, she thought, other undiscovered sources of radiation, and she wondered what particular characteristic there was in the ore that gave uranium its properties.

Like a good scientist, she began at the beginning. Uranium was extracted from pitchblende. Very well, she would study pitchblende. She noticed that it was "radio-active"—a term, by the way, which she created. More than that, she discovered rays many times more powerful than those of uranium.

In her biography of her husband she wrote, concerning this discovery: "I formulated the hypothesis that pitchblende contains in small quantities a substance much more active than uranium itself. This substance would not be one of the known elements since these had already been examined. It must, therefore, be a new element. I had a passionate desire to verify this hypothesis as rapidly as possible and I persuaded Pierre to abandon his work with crystals to join me in the search for the unknown element."

Her earliest experiments proved that whatever this new element

was, it was present in pitchblende only in infinitesimal quantities. Her problem now was to get a sufficient quantity of ore. The Austrian government owned the largest of the pitchblende mines in Europe. It was located in Bohemia. When Mme. Curie begged for an opportunity to secure a large quantity of pitchblende, the Austrian government coöperated by sending her a ton from which the uranium had already been extracted.

Now there began a most enthusiastic and exhausting search. Every fraction of the ore had to be handled and examined lest some particle of the precious new element escape notice. It was a matter of submitting almost every fragment to closest scrutiny, and splendid it is to recall that these most intense scientific labors did not distract this remarkable woman from her home duties and obligations. The family income barely provided for the necessities of life, so there was housework to be done, meals to be cooked and served, clothes to be made and mended, and all the thousand and one duties of the housewife that the modern generation has relegated to a quaint and antiquated Victorian age.

The first fruit of her research was the discovery of a new element which she found to contain a highly radio-active substance. She named it polonium, after Poland, the land of her cradle, which, under a merciless tyranny, had driven her out to find shelter and hospitality under more tolerant auspices.

Polonium, however, was an accidental discovery and not the object of her search. Mme. Curie was convinced that there was still a more active element responsible for these radiations of light that emanated from the ore.

If genius is the infinite capacity for taking pains, then Mme. Marie Curie is a genius without any further quibbling. If you tried to collect the pollen of a flower scattered over an acre, or if you sought to extract gold from sea-water, you would have some idea of the problem that confronted that remarkable woman, whose efforts were finally crowned with success. After repeated crystallization and re-crystallization and precipitation and re-precipitation, in order to separate this new element from the multitude of other substances contained in pitchblende, radium was discovered. Not pure radium, but one of its salts. Chemically it resembled barium, but its spectrum, which is specific for every element, was characteristic for

radium. Moreover, its atomic weight was so high, that the specific identity of a new element—radium—was proven. Here was a substance which represented a ten millionth of one per cent of the ore from which it had been extracted, and its radio-activity in a pure state was one million, three hundred thousand times greater than that of uranium.

The Curies announced their discovery with the simplicity of true scientists. Here they had found an element which approached the fabled idea of the philosophers' stone. In its presence, other elements were transmuted into new substances. From this, geologists found a new way to approach the age of the earth by calculating the time that this transmutation required. Finally it was destined to enter the field of healing as the most pregnant hope in the inhibition and destruction of that most malignant disease—cancer.

Mme. Curie was a woman small of stature, timid and frail. She was most retiring in disposition and it is said that when she was flattered with praise her hands trembled and her voice shook. In 1902, she and her husband were awarded the Nobel prize and eventually she was elected to the French Academy, the first woman to be so honored. The Curies received no pecuniary reward for their great discovery. The money that came with the Nobel prize was used in the equipment of a new laboratory. Mme. Curie personally tended her two children because she was too poor to engage competent servants. She felt the despair of her poverty. In one of her books, she naïvely asks the question, "What reward does society offer the scientist? Is he given means to work? Is he assured an existence? Is he sheltered from care?" And then she pitifully states, "My husband had none of these." And it was not many years after their triumph that Pierre Curie died, tragically crushed under the wheels of a truck as he was hurrying home from a reunion of professors. The shock of it almost killed Mme. Curie. Her only solace lay in the care of her children and in throwing herself even more intensively into her work.

The future of radium is in the hands of thousands of investigators all over the world. It is being applied in ailments of all kinds and is considered a valuable eliminator in diseases due to retention of the by-products of metabolism. It is supposed to prevent, or at least postpone, the hardening of our arteries, and so contribute to

lengthening the human life span. When its stimulating and caustic properties are properly applied; when its actions and reactions are more closely studied and its activities bridled to obedience, no one can tell what magic its use will contrive. That is a problem of the future and we may well look toward its solution with hopeful enthusiasm.

Man has ever been a nature worshiper, and among its various forms he has made his most devoted genuflections before that great ball of fire that we know as the "sun."

And for good reason. Its divine light dispersed the horrors and fears of the dark night. Its friendly breath brought him comfort against the biting chill of wintry weather. Its healing warmth assuaged his aches and pains and he felt invigorated and refreshed. And finally, when the sun shone upon his fields, his crops grew in abundance and his cattle thrived. Many are the legends concerned with the sun. And many the song and prayer that have been lifted in its praise. Hippocrates knew the value of sunlight as a therapeutic measure and ever since his day, doctors have considered the sun their friendliest ally. No one knew just how the sun exerted its beneficial faculties. The answer came in a roundabout way.

In those days, when ships that went out to sea were at the mercy of wind and tide, every careful captain included a supply of limes and lemons with his cargo. For it had long been known that when men subsisted on cured rations and potted foods, they developed the terrible "scurvy," a disease which rendered their gums spongy and painful and produced hemorrhages in the muscles and joints and over their bones, and in many instances killed them practically by letting them bleed into their own tissues. The juice of fresh fruits of the citrus family was a cure for the disease. In the slang of the landlubber, the sailors were known as "lime-juicers." But the seaman had learned that it was a lemon rather than an apple a day that kept the doctor away.

Following the Spanish-American War, the Philippine inhabitants acquainted the American Army surgeons with a malady rarely seen in this country, known as beriberi. This was found among natives whose diet was largely confined to polished rice and dried fish. The afflicted died in convulsions. When the rice polishings were added to their food, the scourge began to wane. Evidently there

was something present in the polishings that was not present in the rice, that pointed the difference between health and disease. Once the observation was made, the laboratory men rushed to the problem. Beriberi was produced in animals by feeding them nothing but polished rice. And the term "necessary food factor" appeared in medical literature. Food that we eat must have more than bulk and nutritive value. It must be more than mere fuel.

The human diet had been reduced by the food chemists to so-called "caloric value." By caloric value is meant the amount of energy the food would produce if burned outside the body. It is a measure of heat. Certain foods in their process of oxidation are capable of producing more animal heat than others and these heat units are called "calories." A low caloric diet, therefore, is one which will produce a lesser amount of animal heat than a higher caloric diet. If we eat more than we burn, we gain weight. If we eat less, we lose weight.

But to return to the "necessary food factor." When rats were fed a mixture of purified proteins, fats, carbohydrates and mineral salts, even as they would appear in natural food, calculated down with chemical nicety to a caloric value that should sustain the life of any rat, it would be found, to the amazement of the experimenters, that the rats did not develop or grow. Heretofore it was believed to be an established fact that a combination composed of the aforementioned substances, including water, determined all of the necessary ingredients for nourishment.

Further experiment revealed the fact that when a little fresh milk was added to the diet of the rats they thrived and prospered. Evidently there was something in fresh food that was not present in its chemical counterpart. This led to the discovery of the vitamins. A vitamin, literally defined, is a substance of nitrogenous nature necessary to life. Several of these vitamins have been identified and studied and many more will probably come to light. They have been found in practically all kinds of food in greater or lesser degree. They are lavishly contained in fresh fruits and vegetables and this discovery has led to a rationalization of all diets, especially the diets of infancy. And soon, that very prevalent disease, rickets, which has been proven to be due to an insufficiency of vitamin content in the food, was rapidly being eliminated from the nursery.

A word about vitamins. Three are recognized at the present writing. Two or three others are in the process of being examined and authenticated. "Fat-Soluble A" is the vitamin generally believed to be "anti-rickets" and necessary to the normal growth of young children. It is very abundant in butter, egg-yolk, and cod-liver oil, milk, and cream, and in certain fresh vegetables, such as spinach, tomatoes and lettuce. That is why spinach and tomatoes have been so generously added to Baby's menu.

"Water-Soluble B" is the "anti-beriberi" vitamin. It is very widely distributed among foods. It is not affected by cooking and so beriberi has practically been eliminated as a disease merely by prescribing a mixed diet.

Then there is "Water-Soluble C," the anti-scurvy vitamin, which is especially found in fresh fruits and vegetables, particularly in lemons, oranges and grapefruit.

The exact constitution of the vitamins is unknown and their ultimate function remains to be discovered. We do know that very small quantities are sufficient for the body's needs, so that any one eating a balanced diet need have no fear of vitamin deficiency.

This brings us back to the influence of the sun. Sunlight affects the vitamin content of every living thing it shines upon. Food kept away from sunlight soon loses its life-sustaining powers. The sun, then, is the great curative principle. Its actinic ray, upon which this benign property depends, has been counterfeited in the many sunlight machines that are now upon the market. It was found that our window glass excluded these rays from our homes, and solariums are now built with quartz windows in order to permit the sun's blessings to fall upon earth's children. The beneficial effects of cod-liver oil have now been discovered to be due to its rich vitamin content rather than to its fat. It is furthermore supposed that it is the cod's absorption of actinic rays as it sports in its sunlighted seas that surcharges its liver with vitamins. Sunlight has become a very definite and specific aid in the treatment of many diseases. Not only does it kill bacteria, stimulate healing and revivify tissues that have lost their power of defense, but it supplies the very energy to our foods without which eating would mean no more than filling the stomach with sawdust.

Light, then, is man's most friendly necessity and to-day the medical man uses it in a hundred different ways; but when he applied its power to make the invisible visible—to make the opaque transparent—he availed himself of the greatest scientific spur in riding that most elusive of all arts—the healing of human ailments.

CHAPTER XVII

The Soul Reveals Itself

A FEW years ago, while in Vienna, the author consulted the fountainhead of soul revelation and asked him this simple question: "What is normality? How would you define it briefly so that, for instance, it would hold water in a court of law?"

The genial Dr. Freud, reflecting the wisdom of a long life steeped in research and investigation, in constant touch with every phase of human nature, merely arched his eyebrows and shrugged his shoulders. Normality, then, is a plastic and varying thing which must be caught to be defined. For it changes with time, with habit, with history, with geography, and with prescribed social usage.

Perhaps it may be most simply defined as that condition of mind and body which enables an individual to adjust himself comfortably and peaceably to a changing environment. Thus walks the normal man, accompanied by two conditions or states of self-comparison: on the one hand, he is dogged by inferiority and deterioration; on the other, preceding him, march talent and genius. No matter which way man turns, whether a step backward or a step forward, he departs from the normal. A step backward is destructive; a step forward is creative, but nevertheless abnormal.

It was Shakespeare who referred to the "poet's eye, in a fine frenzy rolling." The creative, especially in the imitative arts, presupposes a course of thought and action away from the circumferences of normality. A tangent is established, so to speak, which seeks a new goal. To resign ourselves to the worst that is in us, or to rise to the very best, bespeaks in both instances a varying degree of departure from the normal. Could any of our forefathers, with whom our story begins, be brought back to-day they would doubtless seem to us to be demented. Yet, primitive as their mental development must have been, they nevertheless recognized deviations from that state which precluded rational adjustment to one's environ-

ment. For the very earliest records reveal data on the subject of mental abnormality.

In the Old Testament, for instance, the book of Saul teaches us that Saul, King of Israel, was depressed, suspicious, and even mute for long periods of time; that he was given to violent spells of excitement, and even mania, because he failed to carry out Jehovah's command to slaughter a neighboring tribe. This command, according to the Scriptures, preyed upon his mind and "the spirit of the Lord departed from Saul and an evil spirit from the Lord troubled him." Again, there was recorded the delirium of Nebuchadnezzar, in which he believed himself changed into an animal—and "he did eat grass like an ox and his body was wet with dew from heaven till his hairs grew like the feathers of an eagle and his nails like the claws of a bird."

Homer begins his Iliad with "the wrath of Achilles"—he tells us how Ajax was tortured by the Furies until he fell upon his own sword. Ulysses, perhaps the first case of "wanderlust" ever recorded, simulated madness in order to evade the Grecian draft board.

We hold the ancient Greeks to ridicule, mingled with scorn, for their oracles, and yet we know that astrologers and mediums are doing a lively business in America to-day. Superstitions that had more or less of a religious significance to our ancestors, still dominate the lives of many in our own generation, simply because we are mentally lazy. It is easier to follow a tradition, than to do the little hard thinking necessary to question its fallacy.

Among the first deviations from the normal observed by primitive man must have been the deliriums that accompanied infection, or followed the eating of some poisonous plant, or resulted from the bites of serpents or insects whose venom had a particular affinity for the brain cells. And so, in accordance with their primitive conceptions of God and Devil, madness was due to the possession of the body by a malevolent spirit which entered it in the guise of an imp, a viper, a worm, or of some other despised creature. It was sent to vent the wrath of an offended god upon some poor victim who in innocence or ignorance had displeased him. At times the madness caused the afflicted to grow ecstatic or become exceedingly generous. Then it was considered a celestial

visitation by way of rewarding the recipient for some worthy act.

Epilepsy, according to early literature, was undoubtedly one of the commonest forms of mental disease. Up to the time of Hippocrates it had been considered a sacred malady. As we have elsewhere shown, Hippocrates was the first practitioner to remove epilepsy from the realm of theology and necromancy and to include it in the domain of medicine. Hippocrates concluded that the brain was merely the organ of the mind and that the ancient rites of exorcism and prayer for the expulsion of an invading demon were useless, inane procedures. So he led his patients out of the temples and into the clinic. He began applying the same methods of treatment that he used in ordinary diseases.

Hippocrates recommended baths, sunlight, massage, rest, diet, purging, diversion, exercise, and even isolation when necessary. We use these same methods to a large extent to-day, giving them long Greek names; but actually we vary little from the system introduced by the Father of Medicine.

Two other conditions commonly described by the ancients are melancholia and hysteria. The derivation of these names is interesting. Melancholia, or black bile, was considered to be due to a disturbance of the liver secretion. Hysteria is derived from the Greek word meaning womb, and was supposed to be caused by the wandering of this organ, particularly at the time of the menopause when women were known to develop moody and brooding mental states. In both instances it was a demon who contrived to produce the disturbing conditions.

The first attempts of Hippocrates to rationalize the demonological concepts of insanity met with little fruitful encouragement. The intellectual stagnation of the Dark Ages caused them to be discarded in favor of the old beliefs. Medieval Europe, as we have stressed in another portion of this story, subordinated logic, art and thought to the service of an all-powerful Church. It replaced philosophy with scholasticism and smothered the infant science under a crazy-quilt of mysticism. It became profitable for the Church to consider abnormal mental symptoms the product of a supernatural agency, either good or evil. The threat of hell and the promise of heaven were reins that held the populace to the chariot of theological survival. The symptoms of the insane were

seized upon to furnish irrefutable proof of divine influence. The conclusions arrived at were most fantastic.

Perhaps the oddest turn taken by the human mind, and most characteristic of thought in the Middle Ages, was the creation of the witch and witchcraft.

The struggle for existence was precarious and even hazardous. Men were subject to their liege-lords. They were like so many pawns whose sole purpose in life was to provide protection for their masters, and even die when so commanded. Family life was a mosaic of incongruities. The "right of the nuptial night" was the privilege of the Lord of the Manor. Wherever seeds of rebellion were sown in the morass of awakening minds, they were soon kept from growing by the power that lay in the sword of the overlord, and in the pen of the prelate. Women eked out their frugal existences in comparative safety. In most instances they lived considerably longer than men. This produced an oversupply of old women who, for economic purposes, were practically worthless. And as they grew older, they became subject to the mental infirmities that age brings, perhaps benevolently, to tired and tortured minds.

With their senile deterioration, these old women developed varied symptoms which, according to the popular notion, were due to the possession of their bodies by the Devil. Whenever and wherever evil befell, the community found it easier to blame the old women than to inquire into the real cause. Unhappy, indeed, became their lot. The Bible carried the injunction: "Thou shalt not suffer a witch to live." And if these old women showed some such sign as the "Devil's Claw," which was a patch of insensitive skin; or if they showed any of the numerous stigmata of hysteria, they were either burned at the stake or stretched upon the rack, or handed over to the Church to be dispossessed of the devils that had entered them. There are dozens of records extant showing how devils in the form of bats, crows, snakes and other sinister shapes had been seen to emerge after the victim had been submitted to the most violent treatment. To go "batty" was to be possessed of the devil in the form of a bat. Literally thousands were executed each year as witches, or were thrown into dungeons to perish. These witches were accused of every conceivable crime. They were said

to assume the shapes of animals. The werewolf was a particularly popular delusion. It was supposed to rob graves by night and to eat little children. The child-eating witch of the fairy-tales had her origin in this period of perverted thinking.

Perhaps some perverted old crone developed a delusion that she was a witch and practiced her craft with fiendish pride and pleasure. Her name became anathema in the neighborhood, and at the mention of it children were taught to shudder with fear. Hysteria is a disease, produced and cured by suggestion. During the Dark and Middle Ages, it was rampant on a wholesale scale. The Crusades were poignant examples. From the cradle men were raised to have faith. They were taught to believe what they could not prove. And so, benighted by an intangible hope, they were the willing tools of theological suggestion and persuasion. Once an idea gained footing in a community, there were thousands who pursued it with blind zeal. If one witch was an old woman, then naturally all old women were potential witches, so they went around sticking pins into those of the gentler sex who had attained their allotted threescore and ten. There are many well-intentioned old ladies to-day whom we might submit to the same tests and find neurologically and psychologically abnormal. We treat them with patient tolerance and flatter their caprices as the kindly foibles of second childhood.

Not so in America in the days of Cotton Mather, a self-esteemed cleric, who was descended from the Puritan fathers and who plied his trade of avenger of faith in the early days of Salem. If an elderly lady did not respond to a pin prick with a cry of pain, or if her conduct seemed in any way peculiar, the reverend clergyman had her dispatched without undue ceremony. Our only hope is that his reverend ghost stalks about restlessly in the knowledge of the fact that death is a blessing to demented senility.

Not until the eighteenth century did a certain amount of light filter through man's befuddled ideas concerning insanity. With the decline of scholasticism came a reversion to the Hippocratic attitude toward diseased minds. The afflicted were then segregated from society and thrown into dens so horrible that they beggar description. They were treated worse than swine. They were completely at the mercy of unscrupulous attendants, many of them

convicts, who used the whip and the chain with indiscriminate brutality. The revolting misery and the inhuman conditions seen in the asylums have been pictured by Hogarth. It is Hogarth, the artist, to whom credit must be given for the first humanitarian impulse toward the mentally afflicted. He inspired progressive doctors to realize that the insane had the right to be treated like human beings.

In England, Conolly made his first pleas for humane treatment for the insane. Following him, Pinel in France instituted the first radical changes in treatment, by removing the strait-jackets and chains that bound the unhappy patients. As a result Pinel himself was tried for insanity, but fortunately was acquitted.

Typical of the attitude toward mental disease are the written comments of Heinroth, a physician of Leipsic, who tried to throw some order into the chaos of psychiatry. He wrote: "Whatever one may say, there is no mental disease except where there is complete defection from God. Where God is, there is strength, love, light and life. Satan is weakness, darkness, hatred and destruction. An evil spirit, therefore, abides in the mentally deranged."

Since Heinroth died in 1843, it can be seen that up to that date superstition was still linked with the concept of mental diseases. With the development of the microscope, research was directed to the anatomy, histology, and physiology of the brain. Specific areas of the brain, presiding over specific functions, were soon mapped out. It was found that definite areas controlled the special senses. Also a specific motor-area presided over the action of the skeletal muscles. Considerable enthusiasm greeted these discoveries, promising the hope that the cause of insanity soon would be divulged. The material physiology of the brain gave no clew, however, to the psychological variations of the human mind. The finest conception of the brain cell was insufficient to explain that most mysterious of all forces—"Human Thought."

Two patients, let us say, presented similar pictures of mental disturbance. Each thought he was Napoleon, and yet was quite content with his asylum imprisonment and the menial duties imposed upon him. They had completely lost their sense of values and were quite evidently insane. Both died! In one instance, the post-mortem showed the brain to be perfectly normal. In the other, its

tissues were shown invaded and destroyed by an angry inflammation, resulting from syphilis. Here was a philosopher's problem.

Music is a concord of sweet sound which, through the medium of the ear, reaches the consciousness and soothes "the savage breast." Its production depends upon two factors: the musician and the instrument. So is a mental impression of any nature brought to us through our senses, and through our consciousness interpreted into our understanding. For production and reception, two faculties are necessary: mind and brain. The mind is the musician; the brain is the violin. When either one is impaired the music of life becomes a discordant jangle.

The first scientific laboratory for the investigation of psychological progress was established at Leipsic by Wilhelm Wundt in 1879. Our own Stanley Hall and Emil Kraepelin were among his pupils. Kraepelin was the first to attempt to differentiate mental diseases and catalogue them in an orderly way, and it is largely to him that our modern progress in psychiatry is due. Perhaps one statement made by this great genius, who spent a long life of arduous investigation and painstaking effort in the field of mental diseases, will illustrate the great problem that the study of the mind presents to the psychologist. Kraepelin said that after spending forty years in his attempt to understand a certain type of lunacy, dementia præcox, he was left as much in the dark as ever.

Broadly speaking, there are three forms of change in the normal attitude toward human experience and rational action, that dominate the picture of derangement. First, excitement, or overemphasis of reaction. Second, apathy, or retraction of consciousness to the necessary functions of life. Third, perversion, or the misconception of the values of existence, from both a reasonable and an emotional standpoint. No definition can embrace the conception of insanity with greater latitude than the immortal words of Hamlet,

> "And blessed are those
> Whose blood and judgment are so well commingled,
> That they are not a pipe for Fortune's finger
> To sound what stop she please."

When our blood and judgment—our emotions and our reason—are so happily mated that none of the trials and discords of life can interrupt their harmonious union, we may indeed consider ourselves blessed with the greatest benediction of God—a sound mind. Apart from the purely quantitative changes in human thinking and feeling, such as deterioration of reason, memory, capacity for effort, ethical values and so forth, there are a few commonly seen symptoms of a qualitative nature which characterize the unsound mind. These may be briefly considered.

Hallucinations—are false sense *impressions.* The patient hears and sees things that have no existence. These hallucinations are generally concerned with his own intimate life.

Delusions—which frequently accompany hallucinations, are false *beliefs.* Here the patient does not see the faces or hear the voices, but believes in the existence of false creations. Fiction becomes fact to him. The dream is a reality. Delusions are mostly concerned with ideas of grandeur, in which the patient identifies himself with some great personage; a king or a military hero or a statesman. They are also of a persecutory nature, in which the patient believes that some one, or any one, is conspiring to injure him. The same case often shows all of these abnormalities. A man thinks he is a king, hears the voices that proclaim him and is certain that a hostile group plots to keep him from the throne. This prompts him to anti-social conduct. He may fix his revenge upon any one he believes to be leader of his opponents. Having lost all sense of the nature of his act, he may take the law into his own hands and inflict serious injury upon an innocent bystander. Or, if he is unable to cope any longer with the torment of his frustrated existence, he takes his own life.

Another common symptom is *obsession.* Here the patient is hounded by an idea from which he cannot release himself. The obsession differs from the delusion in that the afflicted individual knows the *falseness* of his conception but cannot banish the *feeling* of its reality from his mind. Obsessions are met with in normal people. All of us have certain penchants, certain rules of conduct and habit from which we are able to divorce ourselves only with difficulty. We all know the boy who makes no headway because his boss has a grudge against him, and the man who is compelled

to go back to his home to see that the door is shut. We also know the woman who has every disease she reads in the patent medicine advertisements, but who outlives us all. The name of these cases is Legion. In the neurotic and the insane, however, the obsession dominates to a degree that makes it exceedingly painful, or it may so narrow its scope that practically nothing else enters the field of consciousness.

It is impossible here to dwell at any length upon all the symptoms that the vagrant mind presents; nor is there space to furnish examples of the innumerable and tragic variations from normal conduct that, in these days of stress and strain, of speed and competition, are adding alarming numbers to the army of the asylum.

Human conduct begins with Concept. From the world at large, without and within, impulses come through the medium of the senses and perceptions to bring us to certain Conclusions. These conclusions are fed by streams of thought and feeling—pleasant or unpleasant, freely flowing or restrained—until a decision is reached. This, in turn, becomes an Action. And we are judged by our actions and deeds.

On its apparently instantaneous pilgrimage, the original concept meets with innumerable obstacles and is urged by innumerable prods. It may attain the arena of action, or it may be repulsed for reconsideration. It may be painfully exiled to the sphere of memory as a wish unfulfilled or a desire suppressed, or a passion stifled at its very birth. We have, until recent years, looked upon insanity as a condition that defied logical explanation. Even to-day many people regard it as a curse, an intangible blasphemy heaped upon the unfortunate victim by a cruel and fiendish Fate. Yet, if we enter into the tortuous maze of the soul, we shall find that even the most abstruse and quixotic expressions of lunacy are not very different from tendencies which can be snared within our "normal" minds.

In no branch of the practice of medicine is the individuality and the personality of the patient as paramount in importance as in mental diseases. Here the contributing factors include Heredity, Breeding, Embryonic Existence, Birth, Early Training, Character Molding, Caprices of Adolescence, and in broad terms the entire influence of the Environment, embracing Habits, Trends, Tenden-

cies and the accidents of Infection and Injury. Every classification that sought to catalogue the symptoms of insanity into definite groups ran afoul of innumerable dovetailings and contradictions.

As we have before stated, the normal mind is as a rule concerned with one idea or concept at a time, which prompts it to some definite action. Let us assume, however, that a man is driving a car. At the same time, he is engaged in conversation. He is doing two things simultaneously, and each one is a complicated form of mental activity. The mind is, so to speak, divided into two parts, or, as psychologists are apt to term it, the man's *consciousness* is *dissociated*. It is occupied with two activities, but each one is under his control and may be abandoned at will.

A most startling example of dissociation of consciousness is seen in Automatic Writing. During the war and the influenza that followed, the tragic loss of thousands of our dearest ones spurred a very natural revival of spiritism. We sought to alleviate the bitterness of our grief in the easing hope of a future life, and automatic writing was a form of communication that mediums employed to bring us into contact with departed souls. These mediums, when not faking, are afflicted with a form of mental disorder known as Hysteria. When examined, we find that while engaging in conversation, they will still be able to write answers to totally different questions that a third person whispers to them. When in their so-called trance they will frequently answer questions concerning themselves that in the complete possession of consciousness they have absolutely forgotten. What has happened to the mind of the medium? A dissociation has taken place. The field of consciousness has been divided. It juggles two problems and, what is more remarkable, neither one is related to the other nor aware of its presence. Here we have a type of dissociation that so far transcends the average normal that it falls into the domain of the abnormal.

Then there are even more striking cases—cases of Dual Personality, upon which the famous story of "Dr. Jekyll and Mr. Hyde" is based. Here, there occurs a definite breach or gap in the process of human thinking. The train of thought is broken into two or more completely separate and unrelated phases of consciousness, and for the time the entire psyche of the patient is

dominated by one of them. People who walk in their sleep present this type of dissociation. Their minds can be compared to the effect that would be produced upon us if we were watching one moving picture, and suddenly another entirely different film were flashed upon the screen. Cases of Amnesia, or forgetting one's identity, so frequently appearing in the press, are further examples of this form of dissociation.

We occasionally see, in practice, a woman whose hope of maternity has been spurned by a delinquent stork. Each month she looks yearningly for his coming. Then the aggrieved mind seeks to relieve itself by a process of dissociation. The woman goes through all the symptoms and signs of pregnancy, to a degree of verisimilitude that baffles the diagnostic skill of the most competent obstetrician. After the ten lunar months, Nature reasserts herself. No child is born. The fictitious mother resigns herself to her fate, but the pain of the mind's disappointment has been temporarily assuaged by the feigned fulfillment of the desire.

By dissociation of consciousness, then, we mean a mental state in which a system of ideas is separated from the integrated personality, and in which its course and manifestation are beyond the control of that personality. The normal mind is open to conviction. The psycho-pathologically dissociated mind is proof against proof. Little worlds within the universe of the mind are cast off and, creating their own orbits, steal a portion of the soul-fire of consciousness occasionally to the enlightening, but usually to the destruction, of human personality.

When the magic wand of imagination first touched the intellect of the genial Dr. Freud, he must have felt like the pioneer in Keats's sonnet, standing before a new ocean. But Freud's was the ocean of the human soul beside which the charted seas are as dewdrops. A young woman had come to him complaining of the fact that she could not swallow. All physical tests and examinations were negative. Ordinarily she would have been classified as a Hysteric, and hypnotized, browbeaten, or medicated into submission, or cauterized with hot irons, or shocked with electric currents, or prayed or humbugged into apparent cure.

Freud analyzed her. He uncovered something she had forgotten. She had seen a dog fed at the table, lapping up some water from

the drinking glass of his mistress. The sight so shocked and revolted her that when she tried to swallow some water a painful spasm prevented her from doing it. Here was the human soul revealing its disgust in a physical manner. It registered its offense in a tangible way although the patient was absolutely unaware of the origin and cause of her affliction. When the reason for her aversion to drinking water was brought to her consciousness, lo and behold! she drank without pain or difficulty.

There, in a water glass, was the beginning of the Freudian method of psycho-analysis. It is impossible here, and would be unfair, to say the least, to attempt to crowd into a few pages the libraries that have been written upon the subject within the last generation. But a brief description of the method of the analytic system is not out of place.

In the realm of the soul, as in the workaday world, every phenomenon must have a cause. Chance has no more place in psychology than it has in physics or chemistry. Every casual and irrelevant thought that flits through the mind is only the natural consequence of the mental image that inspired it through the conscious or unconscious association of ideas. Psycho-analysis is the attempt to ascertain the causes that determine the expressions of our consciousness in deed and in disposition—that is, in what we do and in how we feel. We all know what a hobby is. It is a pursuit that engages our interest because we are reasonably and emotionally fond of it. We ride it to our heart's content. All is fair and warmer. Now when a hobby rides us—then, in technical language, we have a Complex. All is cloudy and storms threaten. A complex is an appetite which must be appeased—even though the food may be unwholesome. It may exist in the conscious or the unconscious mind; that is, we may be either aware or unaware of its presence. In many instances, the complex determines our feelings, our opinions and our attitudes toward life. It is a twin sister of the primordial will and defies all the onslaughts of contradicting logic. It makes the man convinced against his will—of the same opinion still. It is the cornerstone of political affiliation, of religious brotherhood, and of professional loyalty. It is the prompter of love and leads to woe and disaster when it is unable to give the right cue. The brunette becomes a matrimonial failure simply

because she has chanced to marry a gentleman who subconsciously preferred blondes—and, not infrequently, vice versa. Many of us who believe our opinion to be based upon a rational and logical premise will find, upon analysis, that our point of view has been watered by streams of an emotionally controlled complex. Bias and Bigotry, as well as Faith and Martyrdom, are its pensioners.

We are prone, however, to repudiate these emotionally toned instincts and traditions as the blind directors of our destinies since such causal factors are not compatible with our ideas of rationality. So the mind seeks to substitute a fictitious logical process for the complex, and to persuade itself that its viewpoint is the normal and natural result of that process. This attempt to manufacture a reasonable channel of exit for pent-up emotions is called "Rationalizing." Rationalizing is the new reason given by us for our conduct, after we have done something for a reason that we would rather forget or suppress. This explains the zealot, who turns to a Higher Power when he has failed in his conflict with men. It explains the malcontent who cries for the universal annihilation of individual possessions because he has been denied the favor of luxury. It explains in many instances the drunkard, who transforms himself into a beast in order to avoid the pain of being a man. It explains, in short, every flight from painful reality into the fantastic dream-world of a happier existence. This flight is known as a "Neurosis"—a condition wherein alibis are substituted for performances of obligations. Envy, Jealousy, Spite, Hatred, Malice and Disloyalty—in fact, all the imps of our ethical Cosmos are apt to possess us and govern our actions at odd times. Yet it is an individual of rare honesty who will admit his conduct to be affected by these degrading passions, and who will not seek to justify that conduct by a self-acquitting rationalization. His tendency will incline him to find some noble motive for his behavior, which he reiterates until he himself believes it to be true. That is why we must have courts of law, and why in both civil and criminal cases our motives as well as our actions reflect the character and nature of our offenses.

In the normal mind, the complex is an irritant easily rationalized, easily sublimated, and easily expunged. In the neurotic the complex is more firmly rooted in the Ego, but its insult is removed for a time by deviating his attention to other pursuits, by changing his

environment, by increasing his resistances, or by dulling the acuteness of his perceptive mechanisms. Or else, the psychic "foreign body" may be revealed through the process of psycho-analysis. It may be dug out of its shadowy retreat in the subconscious mind, its sinister symbols clarified and explained, and its self-imposed and forbidding censorship destroyed by the painstaking psychologist whose mission in life is to understand the suppressed and secret yearnings of the soul and to give them "a local habitation and a name."

It would be beyond the point here to dwell upon the methods of psycho-analytic procedure, as it would have been impossible to describe the technique of every specific operation in the chapter on Surgery. Indeed, it would be far more difficult since it would lead us far afield into speculative problems. We have learned one fact, namely, that in each of us live two beings. One, that God made, and one, that circumstance compels us to be. And between the two there is an eternal conflict. The most normal, psychologically, are those in whom the two beings most happily merge.

In the insane—the complex lies too deep for probing. Or else, it has been hidden behind so heavy a veil of melancholy that no beam of light can penetrate it. The process is probably one of degree, and throughout the world doctors are giving their best efforts to a study of the inscrutable chaos of insanity, seeking to show a cause and effect in its benighted battle, and patiently awaiting the peace that psychological understanding will bring it.

In our era, then, when health and happiness are menaced by malady, the afflicted one presents, as heretofore stated, a dual problem to his physician: What disease has the patient, and what patient has the disease? The doctor approaches his task not only as a diagnostician and healer, but as a priest and confessor to whom human nature is revealed in all of its ever-varying panorama. We know to-day that disease is the result of tissue deterioration and of new growth, of injury and infection, of vicious habits and of foreign poisons, of the very stress and strain of existence, and of the unseen excoriations of the soul with which the human spirit is so mysteriously tabernacled. Disease, like greatness, may be congenital, acquired, or thrust upon us, and doctors are the custodians of a precious stewardship, who even in their greatest suc-

cesses still renounce all vainglory in the knowledge that they are but the ministers of a Mightier Power.

The story of the struggle for health does not end with this paragraph. It is doubtful if its ending can even be surmised. Men will go on suffering, living and dying as they have always lived, suffered and died. As old problems are solved new problems will arise out of the new conflicts that life continually presents. Even as this book is written, a martyr Noguchi gives his life to Mankind in the old struggle against the microbe. Mental conflict is certain to demand its price, and mental conflict has become a commonplace of a bestirred and groping world.

We cannot, then, provide a very happy ending. We can but point to the foregoing pages to show what man has done to ease the pains and travail of Man. After all, we have tried to tell a story and not to solve a problem. Having begun with "Once upon a time, we should be pleased to end with "and he lived happily ever after." Fortunately, this is not likely ever to be the case. In the very element of uncertainty lies, to some extent, the flavor of life.

There remains this consolation—that although the goal of research and discovery is as distant as the remotest stars, a great army of medical men is scattered over the entire world front, engaged in an endless war against our physical and mental woes. Doctors labor untiringly in their scientific laboratories. Inch by inch they crawl along, blazing a trail, constantly coming upon the obscure and the unknown. No danger is too great; no sacrifice too generous; no hazard too forbidding to stay their patient progress.

To-day some new hormone is found and its relation to an entire mosaic of physical and mental maneuvers, clarified and explained. To-morrow a new vitamin, or drug, or serum is discovered and, after painstaking experiment, submitted to clinical test. Again some new theory of physiological action or psychological reaction is given the world to stand the test of time.

It would be superfluous to dwell upon the achievements of science in this age of mechanical advancement. Having split the atom, science is hewing toward the very core of existence. It is no longer necessary to seek our answers to the mysteries of natural phenomena in stars and oracles. Even the elements are being harnessed to obey the will of man. Surely, life is not as hard as it

used to be. We look back with pity and consternation upon the ignorance of our ancestors and wonder how they survived.

The human life span has been considerably increased. The early recognition of disease, intelligent medication, timely surgery, hygienic training, and the scratch in time, have dulled the scythe of the grim reaper. And when "function is smothered in surmise," and the human mind cloaks itself in the dour garb of neurosis and insanity, the doctor to-day is in many instances capable of reading its vagaries and restoring it to normal activity.

How soon shall we understand the eternal verities of life? When will the Struggle for Health simmer down to that point where the ounce of prevention will actually make the pound of cure unnecessary? . . . We cannot answer, but we can find great comfort in this: that while we journey from the cradle to the grave, the battle in our behalf goes on. The soldiers of science are well equipped, and with unflinching courage they continue. And they are grateful that the world at large is gradually being educated to give them the enthusiastic coöperation and support that their struggle deserves.

THE END

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